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International Conference on Applied Mathematics in Engineering

June 27-29, 2018 - Balikesir, TURKEY

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Preface

We would like to welcome all participants to join "The First International Conference on Applied Mathematics in Engineering (ICAME'18)", which will be held from June 27 to June 29, 2018 in Burhaniye/Balikesir, Turkey.

This conference allows an ideal academic platform for researchers to present the latest research and evolving findings of applied mathematics on engineering, physics, chemistry, biology, and statistics.

The conference also provides the opportunity of discussing advances in the field of applied mathematics, its effect on engineering and real-life problems. Especially, the conference discusses the most current applied mathematical problems in the world. For example, fractional calculus and its real-life applications, mathematical modeling in health science and engineering, optimization and control in engineering, non-linear dynamical systems and chaos, optimization and control problems are main topics of the conference.

In this conference, 224 oral presentations will be given to an audience with over 180 participants from 15 countries including Turkey, Argentina, Germany, Pakistan, India, Libya, Iran, United Kingdom, Portugal, Romania, Bulgaria, Morocco, South Africa, USA and Saudi Arabia.

We would like to express our gratitude to the Rectorate of Balikesir University for their support and Balikesir Metropolitan Municipality President Zekai Kafaoğlu, Karesi Mayor Yucel Yilmaz, Altieylul Mayor Hasan Avci and Burhaniye Mayor Nejdet Uysal.

ICAME18 is an achievement of international cooperation we continuously endeavor to carry out and develop. In this context, on behalf of the chairs of this conference, we would particularly like to thank: Co-chair J.A.Tenreiro Machado (Polytechnic of Porto, Portugal), plenary speakers Albert C. J. Luo (Southern Illinois University Edwardsville, USA) and Jordan Y. Hristov (University of Chemical Technology and Metallurgy, Bulgaria), invited speakers Carla Pinto (School of Engineering, Polytechnic of Porto, Portugal), Mehmet Kemal Leblebicioğlu (Middle East Technical University, Turkey) and Ekrem Savaş (Uşak University, Turkey) as well as the organizers of special sessions, and the members of the international scientific committee for their contributions and supports.

We would like to extend our best wishes to all of you with a hope that you go back with actual and more powerful ideas, and with new science networks renewed or extended.

Best wishes for an enjoyable and memorable conference.

On behalf of the organization committee,

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Plenary Speakers

Albert C. J. Luo

Southern Illinois University Edwardsville, USA

Towards infinite countable bifurcation trees of period-m to chaos in nonlinear dynamical systems with saddle-nodes

In this talk, infinite bifurcation trees of periodic motions to chaos in in nonlinear dynamical systems with saddle-nodes are addressed. The bifurcation trees of periodic motions to chaos in nonlinear dynamical systems is very significant for a better understanding of motion complexity. When a slowly varying excitation becomes very slow, the infinite bifurcation trees of period-1 motions to chaos in nonlinear dynamical systems can be achieved once the corresponding excitation amplitude approaches infinity. Towards infinite bifurcation trees in the Duffing oscillator and pendulum are discussed as examples.

J. A. Tenreiro Machado

Institute of Engineering, Polytechnic of Porto, Portugal

Fractional Calculus: Fundamentals, Concepts and Some Applications

Fractional Calculus (FC) started in 1695 when L'Hopital wrote a letter to Leibniz asking for the meaning of Dny for n = 1/2. Starting with the ideas of Leibniz many important mathematicians developed the theoretical concepts. By the beginning of the twentieth century Olivier Heaviside applied FC in the electrical engineering, but, the visionary and important contributions were forgotten. Only during the eighties FC emerged associated with phenomena such as fractal and chaos and, consequently, in nonlinear dynamical. In the last years, FC become 'new' tool for the analysis of dynamical systems. This lecture introduces the FC fundamental concepts and presents several applications in distinct areas of science and engineering.

Jordan Hristov

University of Chemical Technology and Metallurgy, Bulgaria

Exponential and Related Non-Singular Memories: What is following after that in modelling technology?

The recently appeared fractional operators with non-singular memory kernel described by exponential (Caputo-Fabrizio derivative) and generalized Mittag-Leffler function (Atangana-Baleanu derivative) raise many questions about their properties and mainly about their physical relevance and applications. This lecture focuses on the physics provoking creations of such fractional operators, compare their properties with the features of the well-known fractional operators with singular kernels and mainly, try to clarify what really we may model with them.

Invited Speakers

Carla Pinto

School of Engineering, Polytechnic of Porto, Portugal

On recent applications of non-integer order models to biological systems

Research on fractional order (FO) models has suffered an extraordinary boost in the last few decades. The main reason is that FO models provide a more complete understanding of the complex dynamics of biological systems, than their integer order counterparts. In this talk, we will do a review on applications of FO models to biological systems, with emphasis to epidemiological models. We will discuss equilibria, stability of equilibria, reproduction number, and the role of the FO derivative in the epidemics' drama.

Mehmet Kemal Leblebicioglu

Middle East Technical University, Turkey

Observability, Controllability and Identifiability Problems in Some Unmanned Air, Sea and Underwater Vehicles

Unmanned vehicles have become increasingly important in military and civil world. In parallel with the increasing importance, many research problems have arisen as regards to these vehicles. Among them, maybe the foremost one is the construction of mathematical models associated with these vehicles, which are mostly nonlinear and very complicated. A researcher must decide on how complicated the model should be if a simulation with the aim of design is to be performed on this model. Determination of model parameters and designing the vehicle is a highly nested procedure. Even when a physical model has been constructed, a system identification procedure is often necessary to be used in the development of autopilot and guidance studies. This is basically solving a multiple global optimum optimization problem. Usually, help from the physical side is required; otherwise optimization algorithm may yield a completely unrealistic set of model parameters.

These models are absolutely necessary in order to develop controllers which are called autopilots. There are well known controller structures as well as very interesting nonlinear controllers. Lately, intelligent controllers have been developed for accomplishing certain actions which are almost impossible to succeed with traditional ones.

Finally, these unmanned vehicles frequently operate autonomously; This requires a reference should signal to be fed to the controller. This is the part which is the most intelligent; Usually image processing and pattern recognition kind of computations are followed by target tracking. In this speech, all these problems will be discussed on some unmanned air, sea surface and underwater vehicles that I and my group have developed. Some directions of research will be indicated as well.

Ekrem Savas

Usak University, Turkey

Some New Sequence Spaces

In this paper, we investigate some new sequence spaces of strongly lacunary almost summable sequences, which naturally come up for investigation and which will fill up a gap in the existing literature and introduce the spaces of strongly lacunary almost summable sequences which happen to be complete paranormed spaces under certain conditions. Some topological results, characterization of strongly lacunary almost regular matrices, uniqueness of generalized limits and inclusion relations of such sequences have been discussed.

Special Sessions

Modelling & Optimization

Gerhard-Wilhelm Weber, Poznan University of Technology, Poland
Ramazan Yaman, Istanbul Gelisim University, Turkey
Ahmet Sahiner, Suleyman Demirel University, Turkey
Aslan Deniz Karaoglan, Balikesir University, Turkey
Firat Evirgen, Balikesir University, Turkey

Theme

The goal of this session is to discuss recent developments in applications of optimization methods by bringing together researchers and practitioners working in the field of optimization theory, methods, software and related areas.

Topics

Mathematical programming
Global optimization
Nondifferential optimization
Continuous optimization
Combinatorial optimization
Multicriteria optimization
Equilibrium programming
Operations research
Game theory
Data mining
Population based algorithms
Artificial intelligence technologies
Applications of optimization in natural sciences
Applications of optimization in engineering
Energy systems modelling and optimization

Control Theory & Applications

Kemal Leblebicioglu, METU, Turkey
Metin Demirtas, Turkey
Beyza Billur Iskender Eroglu, Balikesir University, Turkey

Theme

This session aims to discuss a broad range of topics including current trends of linear, nonlinear, discrete and fractional control systems as well as new developments in robotics and mechatronics, unmanned systems, energy systems with the goal of strengthening cooperation of control and automation scientists with industry.

Topics

Adaptive control
Linear and nonlinear control systems
Optimal control
Discrete time control systems
Robust control
Fractional order systems and control
Chaotic systems and control
Evolutionary and heuristic control
Robotic control
Energy management and control
Control of unmanned air and undersea vehicles

Fractional Calculus with Applications in Biology

Dumitru Baleanu, Cankaya University, Turkey
Carla Pinto, School of Engineering, Polytechnic of Porto, Portugal
Necati Ozdemir, Balikesir University, Turkey

Theme

The goal of this session is to bring together creative and active researchers, in theoretical analysis and numerical tools, to discuss recent developments in applications of fractional order models of biological models. Fractional order models have become ubiquitous research topics in the last few decades. Their memory property contributes to a better and profound understanding of the dynamics of real world models, namely of biological population problems. Stochastic and deterministic models and coinfection models, as well as computational models, are welcome for HIV, HCV, Ebola, Zika, etc, in this session.

Topics

New numerical methods to solve fractional differential equations
Deterministic and stochastic fractional differential equations
Computational methods for fractional differential equations
Bifurcation theory
Stability theory
Cancer development models: chaos, synchronization
Applications in bioengineering, medicine, ecology, biology, epidemiology

Numerical Methods in Fractional Calculus

Hossein Jafari, UNISA, South Africa
Mustafa Inc, Firat University, Turkey
Ali Konuralp, Celal Bayar University, Turkey

Theme

In the few decades, fractional differential equations have played a very important role in various fields. Based on the wide applications in engineering and sciences such as physics, mechanics, chemistry, and biology, research on fractional ordinary or partial differential equations and other relative topics is active and extensive around the world. In the past few years, the increase of the subject is witnessed by hundreds of research papers, several monographs, and many international conferences. The objective of this special session is to highlight the importance of numerical methods and their applications and let the readers of this journal know about the possibilities of this new tool.

Topics

New methods for solving fractional differential equations
Controllability of fractional systems of differential equations or numerical methods applied to the solutions of fractional differential equations applications in physics, mechanics, and so forth
Iteration methods for solving partial and ordinary fractional equations
Numerical methods for solving fractional integro-differential equations
Numerical functional analysis and applications
Local and nonlocal boundary value problems for fractional partial differential equations
Stochastic partial fractional differential equations and applications
Computational methods in fractional partial differential equations
Numerical methods for solving variable order differential equations
Perturbation methods for fractional differential equations

Discrete Fractional Calculus with Applications

G. C. Wu, Neijiang Normal University, China
Ioannis Dassios, ESIPP, University College Dublin (UCD), Dublin, Ireland

Theme

Difference equations of fractional order have recently proven to be valuable tools in the modeling of many phenomena in various fields of science and engineering. Indeed, we can find numerous applications in viscoelasticity, electrochemistry, control, porous media, electromagnetism, and so forth. At this point it is strongly believed that the fractional discrete operators can have important contribution in generalizing this idea to classical mechanics, non-relativistic quantum mechanics and relativistic quantum field theories.
The theory of discrete fractional equations is also a promising tool for several biological and physical applications where the memory effect appears. The dynamics of the complex systems are better described within this new powerful tool. The nanotechnology and its applications in biology for example as well as the discrete gravity are fields where the fractional dis- crete models will play an important role in the future.

Topics

New methods for solving fractional difference equations
The Nabla operator and its application
Fractional difference equations applied in physics, mechanics, and macroeconomics
Numerical methods for solving non-linear fractional difference equations
Stochastic fractional difference equations and applications
Discrete time systems of fractional order
Stability results for systems of fractional difference equations
Perturbation theory for systems of fractional difference equations

New Fractional Derivatives and Their Applications

Dumitru Baleanu, Cankaya University, Turkey
Jordan Hristov, Sofia, Bulgaria
Derya AVCI, Balikesir University, Turkey

Theme

Nowadays, there has been an increasing interest to the new types of fractional derivatives. The well-known fractional derivatives such as Riemann-Liouville, Caputo, Riesz are successful for modelling real World problems. In addition, these fractional operators give the memory and hereditary effects in physical phenomena. However, these are non-local operators described by convolution integrals with weakly singular kernels. Due to these structures, some complexities can naturally occur in the mathematical modelling and solution processes. Because of these hardness, many researchers have paid attention to introduce new derivatives with fractional parameter in the last years. Caputo-Fabrizio, Atangana-Baleanu, Beta, Conformable derivatives with fractional parameter are pioneering definitions in this sense.

Topics

Description of new fractional derivatives
New properties of new fractional derivatives
Integral transform techniques in sense of new fractional operators
New analytical/numerical methods
Mathematical modelling in terms of new fractional operators
Foundation of new relations between existing and new fractional operators

Nonlinear Dynamical Systems and Chaos

Huseyin Merdan, TOBB ETU, Turkey
Songul Kaya Merdan, METU, Turkey
Esra Karaoglu, THK University, Turkey

Theme

This special session focuses on the dynamics of complex systems, which are one of the most attractive subjects of the modern sciences. The attractiveness of this particular area arises from two different aspects: The first one is that it provides challenges, which are connected with many uncertainties in description of irregular motions. The second one is methods of investigation, which are not yet well developed and established. Applications of complex dynamics investigations are very important and deal with a wide range of problems. They begin with mechanical problems and extend to earthquake prediction and social sciences problems. We are interested in those investigations in electrical and mechanical engineering, physics, biology, economics, finance, neuroscience, computer sciences, fluid dynamics and earthquake monitoring, which urgently need mathematical modeling of their problems and analysis through nonlinear dynamical systems approach.

Topics

ODE, DDE and PDE based modelling for complex systems
Dynamical systems and chaos
Bifurcation theory
Synchronization
Control theory
Fluid Dynamics
Stochastic complex dynamical systems and randomness
Hybrid systems
Complex networks based-models
Neural Networks
Bio-engineering, bio-imaging and bio-fluids
Population dynamics and conservation biology
Ecosystems
Evolution and ecology
Epidemiology and disease modeling
Neuroscience
Regulatory networks
Cell and Tissue biophysics
Evolution and populations genetics
Cell and developmental biology
Cancer and immunology
Environmental sciences
Social economy systems
Climate change
Financial engineering
Mathematical finance

Analytical and Numerical Methods for Solving Nonlinear Partial Differential Equations

Hasan Bulut, Firat University, Turkey
Zakia Hammouch, Universite Moulay Ismail FSTE Errachidia, Morocco
H. Mehmet Baskonus, Munzur University, Turkey
Elhoussine Azroul, Universite Sidi Mohamed Ben Abdellah, Morocco

Theme

Nowadays, partial differential equations (PDEs) have been recognized as a powerful modeling methodology. Most of the phenomena arising in mathematical physics, chemistry, biology and engineering fields can be expressed by PDEs. Many engineering applications are simulated mathematically as PDEs with initial and boundary conditions. Therefore, it becomes increasingly important to highlight the importance of PDEs and to be familiar with all traditional and recently developed methods for solving them. This special issue is concerned with recent works in the field of partial differential equations, various analytical and numerical methods for solving them and the implementation of such methods.

Topics
Analytical methods for partial differential equations
Iteration methods for partial differential equations
Invariant, symmetry and similarity solutions for partial differential equations
Numerical methods for partial differential equations
Perturbation methods for partial differential equations
Polynomials approximation methods for partial differential equations
Stochastic partial differential equations and applications

Fractal and Fractional Calculus

Alireza Khalili Golmankhaneh, Iran

Theme
The goal of this session is to bring together researchers to discuss about fractal geometry and analysis on them. Fractal analysis was studied using different methods such as probabilistic approach, measure approach, harmonic calculus, and fractional spaces. Recently, F^a-Calculus was suggested as a framework which is algorithmic. F^a-C is a generalization of the standard Riemann calculus which utilized on fractal sets and parametrized fractal curves. F^a-C was used to model the anomalous diffusion in porous media and involves local fractional orders derivative that has important role in the applications. Non-local derivatives on fractal were defined to model the process with memory effect on them. Sup-and supper diffusion were characterized on totally disconnected fractal sets. Any research related to fractal geometry, fractal analysis for different kind of the fractals, or solving corresponding differential equation utilizing numerical or analytical methods, is welcome in this session.

Topics
Fractal dimensions and relations
F^a-Calculus and the generalization
Fractional spaces connections with fractals
Random walk on fractals
Laplacian on fractal
Spectral dimension and connections with the physical properties
Fractal antenna and properties
Fractal geometry application in medical, biomedical, Astronomy, Computer science, Fluid mechanics, Telecommunications, Surface physics

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Integrated Assembly Line Balancing and Feeding Problem

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Abstract

Assembly lines are widely utilized in mass production. The opportunity of producing high-quality standardized products in mass quantities is one of the main advantages of assembly lines [1]. Recently, the mixed-model lines, where more than one product model can be simultaneously produced on the same line, have been popular to satisfy customized demands received from customers. However, the diversity of products produced on the line requires the supply of more diversified components to be mounted on the product [2].

This paper investigates the mixed-model assembly line balancing and feeding problem simultaneously. Given the model sequence, a mixed-integer linear programming model is developed to balance the line and decide the locations of components around the line. A numerical example is provided to depict the importance of handling both balancing and feeding problems concurrently. The preliminary results show the efficiency of the proposed model.

Keywords: assembly line balancing, line feeding, mixed-model lines, MILP.

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Mechanical Fault Diagnosis using the Frequency Response Analysis in Electrical Machines

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Abstract

Frequency response analysis (FRA) is one of the methods used to detect mechanical failures, especially in power and distribution transformers. Mechanical failures occur due to the formation of large mechanical forces, either internal or external. Winding deformations, axial and radial displacements, core movements or connection faults may occur as a result of these mechanical forces [1]. The diagnosis of these failures is crucial to avoiding larger and costly outages. In this method, a low-amplitude and variable-frequency signal is applied to the windings. Then, the difference between the input and output signals are analyzed in magnitude and phase angle against frequency [2, 3]. Actually, the system includes components of resistance, inductance and capacitance. Therefore, the frequency response of the system is directly related to the values of these components. In order to be able to detect mechanical failure with this method, it is absolutely necessary that the FRA measurement of the relevant machine in a healthy state and its results are recorded beforehand. In other words, it is necessary to take a fingerprint before the healthy system. In case of a mechanical deformation will change the impedance of the system, the resonant frequency will arise differences compared to the past measurement and mechanical failures can be detected. In this study, the measurement methods used in the literature, the instruments and connection forms are examined. In addition, circuits used in the modelling of the system and frequency ranges pointed out the faults have been investigated. The use of the frequency response analysis method in different electric machines has also been evaluated.

Keywords: Frequency response analysis, fault, diagnosis

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Alternative Methods for Adaptive Exponential Smoothing and the Effect of Used Constants on Forecasting

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Abstract

Adaptive exponential smoothing methods are one of the preferred methods of stochastic estimation in many different fields of engineering, especially for short-term forecasting [1-4]. It is known that they are more useful than classical exponential smoothing methods, especially when there are level shifts or peak changes in time series. However, Trig-Leach's methods (in 1967) were able to produce unstable results according to classical exponential smoothing methods. Basically, this method was based on the fact that the Alpha value in the simple exponential smoothing was not fixed but variable in each iteration. In the following years, researchers such as Wyhbark (1973) and Dennis (1978) aimed to assign Alpha values to specific values when the control boundaries were exceeded. In the proposed methods such as Teräsvirta (1996) smooth transition regression model (STR) and Taylor (2004) soft transition exponential smoothing (STES), Alpha values produced by a series-dependent function are used, without limit values [5,6]. The majority of these methods, there are constants as in Trigg-Leach method. There are some simple methods such as Pantazopoulos and Pappis (1996) in which there are no constants, and they produce poor results in terms of the accuracy [5,7]. In this study, the effect of constants used in the adaptive smoothing methods on forecasting are investigated depending on the characteristics of the time series. It has been determined that the forecasting errors are mostly dependent on the exponential smoothing coefficient Alpha value, however the constants used in the methods can change the error rates. In this study, it also examined new and different approaches in the literature.

Keywords: adaptive, exponential smoothing, forecasting

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A Labor Migration Model with Fractional Derivatives

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Abstract

It is common to use models of mathematical economics to define the economical processes of a country or a region. These kinds of models are typically developed to study quantities such as price indices, unemployment, financial markets, total volume of the production, and investment demands. Fractional derivatives, which are the generalization of the usual derivatives to the fractional order, are non-local. Hence, they are pretty convenient to dynamically model long time series may involve the remembering effect. Fractional calculus is an effective way of incorporating memory effects. The kernel of power-law defining the fractional relaxation equation presents a long-term memory [1-4].

In this study we present a new model of neoclassical economic growth by considering that workers move from regions with lower density of capital to regions with higher density of capital. Since the labor migration and capital flow involves self-similarities in long range time, we use the fractional order derivatives for the time variable. To solve this model, we proposed Finite Fractional Difference Method, and studied numerically labor migration flow data from Turkey along with other countries throughout the period of 1966–2014.

Keywords: Economical growth model, fractional calculus, statistical application

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Hierarchies in the Clusters of Borsa Istanbul

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Abstract

Investigation of financial markets as complex systems is becoming increasingly accepted and recently majored in the statistical analysis of stock interaction networks. This kind of approach was first directed by Mantegna in [1] using the Daily logarithmic price return correlation between each stock to obtain hierarchical networks. Analyzing this kind of networks let us to get the topological properties of a market and its core information. By the help of an appropriate metric that is based on the correlation distance, a connected graph in which vertices represent stocks can be build and the generated minimum spanning trees would yield the hierarchies.

In this paper, we introduce a method to build a connected graph representation of Borsa Istanbul based on the spectrum. We, then, detect graph communities and internal hierarchies by using the minimum spanning trees. The results suggest that the approach is demonstrably effective for Borsa Istanbul sessionally data returns.

Keywords: Financial networks, graph communities, hierarchy structures, spectral graph theory, minimum spanning trees

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New Optimal Solutions for Additive Manufacturing Production Planning Problem to Minimise Cost

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Abstract

Additive manufacturing (AM), also known as 3D printing, has become even more popular recently. AM is the process of creating 3D objects layer-by-layer from different raw materials (including metal powder) [1-2]. Except from being utilized as a rapid manufacturing technology, AM is now adopted to produce many critical components for major automotive and aerospace companies. Boeing has announced that, by 2012, 22 thousand components necessary to produce aircraft have already been produced using AM. NASA has additively manufactured a turbopump, used as a rocket engine fuel pump, with 45% fewer parts in comparison to conventional production techniques [3-5].

This research presents a mathematical model to minimize costs in an AM process, named Selective Laser Melting (SLM). SLM is a process used for producing metal components directly adding melted metal powder layer upon layer. The model proposed in this research modifies the model proposed by Li et al. [6] to convert it into a mixed-integer linear programming model and solve using GAMS (General Algebraic Modelling System) software. The problem is demonstrated using a numerical example and the test problems gathered from [6] were solved using the coded model.

Keywords: additive manufacturing, 3D printing, production planning, optimization, MILP

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A Numerical Study of Initial Flow Past an Oscillating Circular Cylinder

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Abstract

The initial flow properties for the case of uniform stream past an impulsively started circular cylinder had been discussed for the first time by Blasius [1]. He implemented the boundary-layer theory to calculate the first approximation to the time at which the fluid separates. Collins and Dennis [2] used the boundary-layer theory to capture the development of the physical properties of the flow past a fixed circular cylinder at early stages for finite Reynolds numbers. Over the years, the boundary-layer theory has been effectively used to discuss the initial flow past a circular cylinder with different types of oscillations such as a streamwise oscillation by Badr et al. [3].

The main purposes of this work are: (i) to generalize some theoretical results of Collins and Dennis [2] by obtaining compact explicit forms for the coefficients of the perturbation solution, (ii) to modify the numerical technique of Collins and Dennis [2] by utilizing the collocation method, and (iii) to extend the physical results of Collins and Dennis [2], Badr et al. [3] and Al-Mdallal [4] to the initial flow past a circular cylinder forced to oscillate simultaneously streamwise and transversely to the fluid flow. To achieve these purposes, Navier–Stokes equations in non-primitive variables givn by

$$e^{2\xi}\frac{\partial\zeta}{\partial t}=\frac{2}{Re}\left(\frac{\partial^2\zeta}{\partial\xi^2}+\frac{\partial^2\zeta}{\partial\theta^2}\right)-\frac{\partial\psi}{\partial\theta}\frac{\partial\zeta}{\partial\xi}+\frac{\partial\psi}{\partial\xi}\frac{\partial\zeta}{\partial\theta},$$

$$e^{2\xi}\zeta=\frac{\partial^2\psi}{\partial\xi^2}+\frac{\partial^2\psi}{\partial\theta^2}$$

are solved numerically using the perturbation method together with the collocation method. For more details about the full results, please see Al-Mdallal [5].

Keywords: Combined streamwise and transverse oscillation, Initial flow, Perturbation theory, Collocation method

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Numerical Simulation of Some Partial Differential Equations by Homotopy Perturbation Sumudu Transform Method

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Abstract

In this study, we consider Homotopy Perturbation Sumudu Transform Method to identify solutions of some linear/nonlinear partial differential equations. For this purpose, first of all, Sumudu transform method is applied to the partial differential equation to transform it into an algebraic equation. Additionally, Homotopy Perturbation method with He polynomials is adapted for nonlinear terms. After that, by applying the inverse Sumudu transform to the algebraic equation, the solution of the problem is obtained in serial form. If this series converges, an exact solution of the problem is also obtained. Numerical simulations have displayed that the Homotopy Perturbation Sumudu Transform Method is applicable to both linear and nonlinear partial differential equations easily.

Keywords: Partial differential equation, homotopy perturbation method, sumudu transform

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Applications of Exp (-φ (ξ)) Expansion Method to Some Partial Differential Equations for Finding Exact Solutions

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Abstract

Mathematical models of many problems are encountered in various branches of science corresponding to nonlinear ordinary or partial differential equations. For this reason, the availability of analytical or approximate solutions of such equations has been an important study topic for scientists. For this purpose, many methods have been introduced. In this study, we utilize Exp (-φ (ξ)) Expansion Method to find new exact solutions of some partial differential equations. By this method, partial differential equation is transformed into an ordinary differential equation by travelling wave transformation. After that the solutions of this ordinary differential equation are characterized and new analytical solutions of the partial differential equation are presented. Finally, 2D and 3D graphs are drawn for the obtained solutions to interpret the properties.

Keywords: Partial differential equation, exact solution, Exp (-φ (ξ)) Expansion Method

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An Adaptive Evolutionary Algorithm Integrated with Neighborhood Search Heuristics for Solving Multi-objective Flexible Job Shop Scheduling Problem

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Abstract

NSGA-II is one of the evolutionary algorithms that is widely applied for solving the multi-objective flexible job shop scheduling, which is an NP-hard problem and its exact methods are complex. This algorithm almost finds good results for many problems, however generally, it is necessary to do some modifications according to the problem, for getting better results. In the literature, several approaches have been proposed to measure the effectiveness of the algorithms. The stable converges is among the practical ones that generally shows the efficiency of an evolutionary method. In this study, the effect of using the neighborhood structures on the convergence of the NSGA-II algorithm is analyzed. Some of the used structures are large, while there are also the small ones. In the modified algorithm, different neighborhood structures are applied to the different fronts obtained according to the non-dominated sorting and crowding distance operators. Such that, the small structures are applied to the good solutions, while the bigger neighborhoods are used for the solutions on the downer fronts. Based on the convergence of the algorithm, its performance is compared with the classic NSGA-II. In this way, useful results have been obtained about that which structure should be applied during the different stages of a search. This will also provide a basis for an adaptive variable neighborhood search, defined based on the neighborhood structures, which we plan to design it in our future works.

Keywords: Flexible Job Shop Scheduling Problem, NSGA-II, Neighborhood Structures

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Global Nonexistence of Solutions for a Coupled Nonlinear Wave Equations with Degenerate Damping Terms

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Abstract

In this work, we analyze the influence of degenerate damping terms and source terms on the solutions of the nonlinear wave equations. In this study, we consider coupled nonlinear wave equations with degenerate damping and source terms. We will show the blow up of solutions in finite time with positive initial energy. This improves earlier results in the literature [1-3].

Keywords: Global nonexistence, Coupled wave equation, Degenerate damping and source terms

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Cooling and Pasteurizing Eggs

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Abstract

Preserving eggs against the growth of bacteria for domestic consumption is done either by storing at low temperature or through pasteurization at 60 degrees, [1]. Determining the cooling/heating time for eggs is important from an economic point of view. It is also essential to estimate the related amount of energy used in the process. Eggs are usually modelled as spheres with spherical cores (yolk). It is easy to deal with spherical geometries as the differential equation which governs the heat transfer process can be cast in spherical coordinates. Spherical coordinates are elegant widely used coordinates system for dealing with problems with spherical geometries. Unfortunately, eggs are not perfectly spherical and errors associated with assuming such simplified geometry are present. These errors, which result also from numerical solutions, can be large depending on the axis ratio of the eggs. Eggs are best modelled as having the shape of prolate spheroids. Prolate spheroids have nonuniform axis lengths. The major axis can reach one third longer than the minor axis.

We, here, attempt to determine the cooling/heating time of eggs with appropriate consideration to their actual prolate spheroidal shape. We adopt the prolate spheroidal coordinates system to solve the heat conduction equation which governs the heat transfer process. Various physical conditions such as axis ratio and Biot number which reflects the convection strength of the surrounding medium as compared to the conduction of the egg, are considered. We compare our findings to the case when the egg is considered as a perfect sphere. The later case is well documented in the literature, [2].

Keywords: Egg, Prolate Spheroid, Heat Transfer

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Blow up of Solutions for a Timoshenko Equations with Positive and Negative Initial Energy

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Abstract

In this talk, we consider Timoshenko equations with weak damping terms. We prove the blow up of solutions Timoshenko equation. Timoshenko equation is evolution equations. Evolution equations, namely partial differential equations with time t as one of the independent variables, arise not only from many fields of mathematics, but also from other branches of science such as physics, mechanics and material science. This type equation arises beam theory [1]. Timoshenko [2], a pioneer in strength of materials, developed a theory in 1921 which is a modification of Euler's beam theory. Euler's beam theory does not take into account the correction for rotatory inertia or the correction for shear. In the Timoshenko beam theory, Timoshenko has taken into account corrections both for rotatory inertia and for shear. Also Timoshenko has shown that the correction for shear is approximately four times greater than the correction for rotatory inertia. The modified theory is called the "Timoshenko beam theory". Many authors studied Timoshenko equation. For example; Esquivel-Avila [3, 4] studied global existence and attractor of solution of the Timoshenko equation. Later, Pişkin [5] prove the local existence of solutions for the problem by Banach contraction mapping principle. After that, we obtained global existence, decay and blow up of solutions. Recently, Pişkin and Irkıl [6] studied the blow up of solutions with positive initial energy.

Keywords: Blow up, Timoshenko equation, positive and negative initial energy

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Numerical Modelling of MHD Convection Flow in Cavities

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Abstract

The two-dimensional, steady, laminar flow of an incompressible, electrically conducting, viscous fluid is considered in a square and a lid-driven cavity under the effect of horizontally applied uniform magnetic field. The continuity, momentum and energy equations are coupled including the buoyancy and magnetic forces allowing the energy equation to contain the Joule heating and the viscous dissipation [1]. The magnetohydrodynamics (MHD) convection equations are solved in terms of velocity components, temperature and pressure as well as stream function and vorticity by using polynomial radial basis function (RBF) approximation for the inhomogeneity. Particular solution, which is also approximated by RBF to satisfy both the differential equation and boundary conditions, becomes the solution itself of the differential equation [2]. The physically unknown boundary conditions of the vorticity are obtained using the finite difference discretization of stream function equation [3]. The boundary conditions for pressure are obtained using the RBF coordinate matrix and finite difference discretization of momentum equations for the lid-driven cavity problem. However, for the square cavity the physically meaningful, vanishing normal derivative pressure values are taken on the boundary. The numerical solutions are obtained for several values of Grashof number (*Gr*), Hartmann number (*M*) for fixed Prandtl number *Pr=0.71* and fixed Reynolds number *Re=100* with or without viscous dissipation. It is found that, the isotherms have a horizontal profile for a large *Gr* values as a result of convection dominance. As *M* increases, the effect of the convection is reduced, and the isotherms tend to have vertical profiles. When the viscous dissipation is present, the flow and isotherms are pushed through the cold wall forming boundary layers and thermal layers, respectively. The RBF which is easy to implement provides the solution of MHD convection flow at a considerably small computational expense.

Keywords: MHD, RBF, heat transfer, viscous dissipation

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Stability of Unsteady MHD Flow in a Rectangular Duct

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Abstract

In this study, the time dependent and coupled magnetohydrodynamic (MHD) flow equations are solved in the cross-section of a rectangular pipe (duct) by using the radial basis function approximation (RBF). The MHD studies electrically conducting fluids in the presence of a magnetic field. It has wide range of industrial applications such as MHD generators, MHD pumps, plasma physics and nuclear fusion [1]. The velocity and the induced magnetic field are obtained by approximating the inhomogeneities using thin plate splines ($r^2 \ln r$) [2]. Then, particular solution is found satisfying both the MHD equations and the boundary conditions which are the no-slip and insulated wall conditions. The Euler time integration scheme is used for advancing the solution to steady-state together with a relaxation parameter for achieving stable solution. It is shown that, as Hartman number (M) increases the flow develops boundary layers of order M^{-1} and $M^{-1/2}$ on the Hartmann walls (perpendicular to the applied magnetic field) and side walls (parallel to the magnetic field), respectively. The induced magnetic field also exhibits boundary layers at the Hartmann walls, and the flow flattens and becomes stagnant at the center of the duct with an increase in the Hartmann number. These are the well-known characteristics of the MHD flow. The stability analysis is carried in terms of spectral radius of the coefficient matrix in the final discretized system, requiring the boundedness of spectral radius by one. The implemented scheme "Euler in time - radial basis function approximation in space" gives stable solution by using quite large time increment and relaxation parameter although the Euler scheme is an explicit method.

Keywords: MHD, RBF, Euler time-integration, Stability

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Asset Flow Differential Equations

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Abstract

I will give an overview on deterministic asset pricing models. I will present asset flow differential equations used for modeling a single asset market involving a group of investors. Derivation of models are based on the assumption of the finiteness of assets (rather than assuming unbounded arbitrage) in addition to investment strategies that are based on either price momentum (trend) or valuation considerations. Finally, an example from real market will be discussed.

Keywords: Ordinary differential equations for asset pricing, price dynamics, asset flow, dynamical system approach to mathematical finance.

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Generalized Curvature of the Contact Curve Based on The Local Surface Frame

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Abstract

Industrial robots usually required to move so as to make and maintain contact between bodies. Contacting is found in the use of industrial robots for grinding, polishing, cleaning, parts sliding, and peg insertion [3]. The point contact, line contact, and planar contact between rigid bodies are the most common types of direct contact. Some researchers studied on contact between planar rigid bodies (for example, [1], [5], [9], [10], [12]), but some researchers have been studied on the kinematics of 3D contact between two rigid bodies. Cai and Roth study the kinematics of two contacting bodies in point contact according to spatial motion [2], [3]. Montana finds the equations of contact from a geometric perspective [6]. In this paper, we express the local surface frame and the curvatures of this frame, and relation between the local-surface frame and the Darboux frame on the surface. Using the definition "If there exists a regular surface that contacts to the curve at the neighborhood of the contact point in high order, and contact conditions are described in terms of invariants, then these invariants are called as generalized curvature of the curve which attached to the surface. Also, the surface is called as generalized curvature surface [11].", we examine the point contact between the curve and the surface according to local-surface frame. For this purpose, we express the contact order between the curve and the surface at the neighbourhood of the contact point. Moreover, we obtain the generalized curvature of the contact curve in terms of local-surface frame invariants.

Keywords: Darboux frame, local-surface frame, point contact, generalized curvature.

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The DRBEM Solution of the Cauchy MHD Flow in a Duct with one of the Walls is Slipping and Variably Conducting

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Abstract

In this study, the Magnetohyrodynamic (MHD) flow in a rectangular duct where one part of its boundary allows both the varying conductivity and the slipping velocity is investigated numerically as a direct and an inverse (Cauchy) formulation. The Cauchy formulation of the problem is constructed with underspecified and over-specified boundary conditions for the induced magnetic field and the velocity on opposite parts of the duct walls. The study aims to recompute the induced magnetic field with the conductivity constant, and the slipping velocity with the slip length on the underspecified wall. The governing coupled convection-diffusion type MHD equations for the direct and inverse formulations are discretized and solved as a whole by using the dual reciprocity boundary element method (DRBEM). The DRBEM provides both the velocity and induced magnetic field and their normal derivatives to be used as overspecified boundary conditions for the construction of Cauchy problem. The discretization of Cauchy problems results in ill-conditioned systems of linear algebraic equations, hence a regularization technique is needed to solve such systems [1]. In this study, two regularization techniques, namely as the Tikhonov regularization and the well-posed iterations [2] are performed to obtain the inverse solution of the Cauchy MHD duct flow. Slip velocity and induced magnetic field behaviours are examined for Hartmann number values Ha=1, 10, 50. Discretizing only the boundary of the problem region and providing both the unknowns and their normal derivatives on the underspecified wall are the main advantages of the DRBEM [3] for the Cauchy MHD flow in a square duct so that the conductivity constant and the slip length between them can be recovered.

Keywords: DRBEM, MHD, Cauchy problem, regularization, slip velocity, conductivity

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Power Law of Cross Correlation Between the North Atlantic Oscillation and Precipitation

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Abstract

The understanding of complex systems such as in meteorology or climatology has become an active research area for researchers (or earth scientists) since the works of Lorenz from the mid-sixties. Because of the atmospheric systems are highly complex, it is important to identify interesting dynamic properties such as possible scale invariance, heavy skewness, non-linear correlations, non-stationarity and fractality in the system. Atmospheric teleconnections with strong convective processes have irregularly led to drive impacts on various climatic regimes of the world. The North Atlantic Oscillation (NAO) is such a teleconnection process that alters rainfall to the Mediterranean basin during its negative phase and to Europe during its positive phase. In this study, the long-range relationships between the NAO and precipitation data from the data set named Merged Analysis of Precipitation (CMAP) from 1979–2016 were examined by the method of so called Detrended Moving Average Cross Correlation Analysis (DMCA) in the areas including Europe, the Mediterranean, North Africa, Middle East and Caucasus. The method is usually labelled as the DMCA coefficient, ρDMCA (s), with a moving average time window length s. All calculations were made by a developed source code of Fortran95. Since statistical tests were not yet fully developed on this area, the results were compared with the results those obtained from the random data (Monte-Carlo approach). By applying the DMCA to NAO series, it is found that the NAO fluctuation series exhibit long-range cross-correlation characteristics. Significant long-term relationships are found for some regions and window length *s*, with these teleconnection patterns corresponding to changes in precipitation values in some places. Strong DMCA coefficients are identified for the Mediterranean basin, near polar region of north and northwest Europe when the time window s is greater than 12 months, due to the aggregated vertical atmospheric humidity combined with near-surface conditions.

Keywords: DMCA, Europe, Mediterranean, NAO, Precipitation

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Detrended Fluctuation Analysis of Drought Over Turkey

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Abstract

In this study, the persistence of drought by means of the Palmer drought severity index (PDSI) over Turkey is investigated. A method to sort out correlations and decorrelations in drought occurrence and persistence is introduced. The detrended fluctuation analysis (DFA) statistical method is applied to PDSI. The existence of long-range power-law correlations in PDSI fluctuations is demonstrated from 2 months to decay years period. Moreover, using a finite size (time) interval window, a change from Brownian to non-Brownian fluctuation regimes is clearly shown to define the drought pattern changes. The occurrence of these statistics in the values of PDSI suggests the usefulness for better meteorological drought predictability. DFA frequencies reveals power law scaling up to climatological (30 years) periods; this is related to long-term memory. From a climatological point of view, it is found that the area with high level Hurst exponent is recommended as the areas of those sensitive to droughts falling into the risk ranges of "high" and "very high".

Keywords: DFA, Drought, PDSI, Turkey.

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A Series Formula for Prabhakar Fractional Operators

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Abstract

In 1971, Prabhakar [1] introduced an integral operator with a generalised Mittag-Leffler kernel, which later authors [2,3] have adapted as a fractional differintegral with four or five continuously varying parameters. Other novel fractional models defined by integral operators with non-singular kernels include those by Caputo & Fabrizio [4] and Atangana & Baleanu [5]. All three models – Prabhakar, CF, and AB – have discovered real-world applications. In our recent paper [6], we discovered a new formula for the AB fractional derivative as a series of classical (Riemann–Liouville) fractional integrals.

Here, we demonstrate that the Prabhakar fractional operators can also be written in series form, in terms of Riemann–Liouville fractional operators only. This new formula enables short-cuts to many known results about Prabhakar operators, and provides new fundamental results in this model, such as analogues of the product and chain rules. We also indicate how these results on Prabhakar operators give rise to special cases in each of several other models of fractional calculus, including CF and AB.

Convergent infinite series are an established tool in fractional calculus: e.g. the Grunwald–Letnikov model, or the fractional Leibniz and chain rules. Our new formula may be much more useful for numerical computation of Prabhakar differintegrals than the original integral formula. Furthermore, because the summands are Riemann–Liouville, the series formula reduces many problems and theorems in the Prabhakar model to analogous ones in the classical and better-known Riemann–Liouville model.

Keywords: Fractional calculus, Prabhakar operators, convergent series

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Approximate Solutions to Initial Value Problems for Fractional Differential Equations

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Abstract

Fractional calculus has achieved a great interest in the last decades since many physical problems are modelled with fractional differential equations. In recent works the importance and usefulness of fractional differential equations involving Riemann-Liouville, Caputo and Caputo-Fabrizio derivative, was shown ([1], [2], [6]-[9]). These fractional derivatives are nonlocal. Their definition involves integral operators, some of them having singular kernel, and its calculation is not easy. For that reason, in addition to theoretical developments, it is important to develop numerical approximations to these operators. Several approaches were proposed to solve different fractional differential ([2], [6]).

In this work we build an approximate solution to the Initial Value Problem $D_0^\alpha f + \lambda f = g,\ f(0) = 0$ where $D_0^\alpha f$ is the Caputo-Fabrizio derivative of order α in [0,b], f is the unknown and g is the data.

There are some results concerning existence and uniqueness of solution to this IVP and explicit formulae of the primitive of the data function ([6], [10]).

Following some previous works [3]-[5], we choose a wavelet basis well localized in both, time and frequency domain, with suitable properties: smooth, band limited, infinitely oscillating with fast decay. We apply the wavelet transform and build an approximate solution to the IVP combining the fractional derivatives of the wavelet basis by means of a Galerkin type scheme. The choice of the basis guarantees that the numerical scheme is simple, stable and can be easily refined. We do not need to impose any supplementary condition to the data or to the unknown. We present some numerical examples to show its performance.

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Approximate Controllability of Non-Autonomous Sobolev-Type Differential Equations with Nonlocal Conditions

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Abstract

In this work, we study sufficient conditions for the approximate controllability of a class of Sobolev-type non-autonomous differential equations with nonlocal conditions in a Hilbert space X :

$$\frac{d}{dt}[\mathrm{Ex(t)}]+\mathrm{A(t)\,x(t)}=\mathrm{f}\left(\mathrm{t},\mathrm{x(t)}\right)+Bu(\mathrm{t}),\ t\in J=[0,\mathrm{b}],$$
$$\mathrm{x}\left(0\right)+g(\mathrm{x})=x_0,$$

where, $A(\mathrm{t}):\mathrm{D(A)}\subset \mathrm{X}\to \mathrm{X}$ is a closed densely defined linear operator with $D(\mathrm{A})$ is independent of t, $x_0\in D(\mathrm{E})$, $E:D(\mathrm{E})\subset \mathrm{X}\to \mathrm{X}$ is a closed linear bijective operator with $D(\mathrm{E})\subset \mathrm{D(A)}$, $E^{-1}:X\to D(\mathrm{E})$ is compact, and $f:J\times X\to X$, $g:\mathrm{C(J,X)}\to X$ be given functions satisfying certain assumptions.

$u\in L^2(\mathrm{J},\mathrm{U})$ where U is a Hilbert space and $B{:}U\to X$ is a bounded linear operator.

The results will be established under the assumption that corresponding linear system is approximately controllable, and by using fixed point theorem and the theory of semigroup of bounded linear operators.

Keywords: Approximate controllability, Semigroup theory, Sobolev type differential equations.

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Fractal Koch Curve Antenna and Their Dimension

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Abstract

Fractal geometry has the significant impact in many areas of science and engineering such as antennas [1,2]. Fractal antennas are used in telecommunications since they have the simple structure, multiband, compact size, and easy integration with the circuit [3-10]. In this paper, we study the relation between antennas characteristics and geometrical properties of the Koch curve fractals. The fabricated antenna has dimensions of $40\times30\times 1.6mm^3$, and operational frequency bands of the antenna are (3-6.2 GHz) in view of VSWR<2 diagrams [4]. The quantitative link between multiband characteristics and the resonant frequency of the antenna and fractal dimension is presented. The fractal Koch antennas are analyzed and simulated utilizing Ansoft HFSS for design optimization. Radiation patterns of designing monopole antenna are given. The reflection coefficient and measured and simulated are compared.

Keywords: Fractal antennas, Multiband charactristics, Fractal dimensions, Microstip.

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Compressive Spectral Method for the Simulation of the Water Waves

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Abstract

In this paper an approach for decreasing the computational effort required for the spectral simulations of the water waves is introduced. Signals with majority of the components zero, are known as the sparse signals. Like majority of the signals in the nature it can be realized that water waves are sparse either in time or in the frequency domain. Using the sparsity property of the water waves in the time or in the frequency domain, the compressive sampling algorithm can be used as a tool for improving the performance of the spectral simulation of the water waves. The methodology offered in this paper depends on the idea of using a smaller number of spectral components compared to the classical spectral method with a high number of components. After performing the time integration with a smaller number of spectral components and using the compressive sampling technique, it is shown that the water wave field can be reconstructed with a significantly better efficiency compared to the classical spectral method with a high number of spectral components, especially for long time evolutions. For the sparse water wave model in the time domain the well-known solitary wave solutions of the Korteweg-deVries (KdV) equation is considered. For the sparse water wave model in the frequency domain the well-known Airy (linear) ocean waves with Jonswap spectrum is considered. Utilizing a spectral method, it is shown that by using a smaller number of spectral components compared to the classical spectral method with a high number of components, it is possible to simulate the sparse water waves with negligible error in accuracy and a great efficiency especially for large time evolutions.

Keywords: Water waves, spectral methods, compressive sampling

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The Spectral Decomposition of a Covariance Matrix for the Balanced Random Effects Model

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Abstract

The covariance matrix of the balanced random effects model is the linear combination of matrices which are the Kronecker products of identity matrices and matrices of ones. We present the method for deriving the spectral decomposition of this kind of the covariance matrices. Earlier studies on this topic are Searle and Henderson [1] , Wansbeek and Kapteyn [2,3] , Wu and Wang [4] and finally Güven [5]

Our derivation of the spectral decomposition of differs from earlier studies and is based on determining the distinct eigenvalues of a covariance matrix and then obtaining a principal idempotent matrix for each dictinct eigenvalue. Illustrative examples are given.

Keywords: Covariance matrix, Eigenvalue and eigenvector, Spectral decomposition of a symmetric matrix

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On the Analytical Solutions of the Fractional Partial Differential Equations

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Abstract

Nowadays, new fractional derivatives are popular instead of the classical derivatives, Riemann-Liouville, Caputo derivative. In this work, the conformable derivative is considered for the one of popular fractional partial differential equation. Analytical solutions of fractional partial differential equations are more difficult to obtain, as analytical solutions of nonlinear partial differential equations cannot be obtained easily. There are many methods to obtained analytical solutions such as auxiliary equation method, sub-equation method, tanh-method, etc. In this work, the one of models of real world problems is considered and the analytical solutions are obtained via Bernoulli approximation method which is modification of mentioned methods.

Keywords: Analytical solutions, conformable derivative, fractional partial differential equation.

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A Hybrid MCDM Based QFD Approach for Supplier Selection Problem

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Abstract

The primary aim of the supply chain philosophy is to make profits and match supply with customer needs simultaneously. In order to ensure success, the performance of all members in the supply chain should be effective and achieve customer satisfaction. This requires fulfillment of needs of all stakeholders in the supply chain, because of the fact that each of the members is customer of the previous member. Supplier is the first step and a significant link in the supply chain and thus supplier selection is an important strategic decision for reducing operating costs, improving competitiveness and increasing customer satisfaction. Selected suppliers should be the "voice" of customers while providing the company's requests. In this context, Quality-function deployment (QFD) proposes that customer needs influence the supplier evaluation by identifying customer wants (What) and how the firm is going to meet those wants (How). Therefore, this paper presents an integrated hybrid AHP-TOPSIS based QFD methodology to evaluate suppliers. At the first step, AHP is used to determine priority ratings of supplier's customer (stakeholder) requirements. Next, House of Quality (HOQ) that one of the tools of QFD is transformed into House of Supply Chain Management (HSCM) to establish a relationship matrix in order to identify degree of relationship between customer requirements and supplier selection criteria. Then, the importance weights of evaluating criteria are calculated using customer importance ratings and weights of relationship matrix. Finally, based on the weights of criteria, alternative suppliers are ranked by TOPSIS for optimal selection. A numerical example is presented to demonstrate the usefulness and effectiveness of the proposed methodology.

Keywords: AHP, QFD, TOPSIS, supplier selection

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A Simultaneous Optimization Model for Distribution Planning and Supplier Selection in Closed Loop Supply Chain Network

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Abstract

In recent years, recycling activities for used products from end customers to manufacturers have been considerably increased due to government regulations and environmental consciousness of customers. This new paradigm shift requires an effective product recovery network design which known as the closed loop supply chain (CLSC). CLSCs are supply chain networks that includes the returns processes and all traditional supply chain activities as well. An effective CSLC implementation needs strategic decision-making regarding selection of suppliers and optimal order allocations after identifying the appropriate suppliers as well as network design. Therefore, this paper aims to optimize supplier selection, order allocation and CLSC network configuration simultaneously. This study examines a CLSC network managed by a firm with manufacturer, distributor, retailers, collection and recovery centers. The firm meets demands of the customers in the form of new and remanufactured products and evaluate returned products at the same time. Thus, it needs to choose the right suppliers for supplying new parts from the outside and evaluate reusable parts from the inside to minimize cost, increase quality and be environment-friendly. Herein, a two-stage integrated approach is proposed for selecting the best suppliers using a hybrid multi-criteria decision-making method and optimizing CLSC network configuration. At the first stage, AHP is used to calculate the relative weights of supplier selection criteria and then COPRAS is used for ranking (weights) of suppliers. At the second stage, the weights of the criteria and suppliers are incorporated into the proposed model with other formulations. It is modeled as a mixed-integer linear programming model that maximize total profit of CLSC and value of purchasing for suppliers. The proposed model is validated through a numerical example by solving with GAMS software.

Keywords: AHP, COPRAS, CLSC optimization, mixed integer linear programming, supplier selection

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Modelling and 3D Printing of a Complex IPMS Gyroid

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Abstract

Gyroid is discovered by Alan Schoen in 1970 while he was studying super-strong, super light structures. The mathematical equation of the gyroid is complicated because it consists of elliptic integrals. However,

$$cosx.siny + cosysinz + cosz.sinx = 0$$

equation gives an approximation to the gyroid surface looks like the actual gyroid [1]. Because of this, the above equation is considered to create a mathematical model of the gyroid by using a mathematical software called K3DSurf v0.6.2 [2]. Once mathematical model created then it is exported to ".obj" data format in order to print it by a 3D Fused Deposition Modelling (FDM) printer [3]. FDM technology is patented by Scott Crump in 1989 for creating three-dimensional objects [4]. The industry of 3D printing is considered part of 4th Industrial Revolution and it is the latest piece in a chain of visualisation techniques [5].

Production of complex mathematical models such as a gyroid is impossible with classical material removing engineering methods. But using 3D printing technology allows us to fabricate such models quite easily [6]. The aim of this study is to fabricate a complex mathematical model of a gyroid in order to use it for active teaching and learning of mathematics and to prove that the above mentioned equation is not only a mathematical expression but also is real life object.

To print the mathematical model of the gyroid a low cost FDM 3D printer is used. MakerwareTM slicing software accepts the ".obj" file format and can slice the model into 2D layers [7]. The software can also calculate the printing nozzle's travel movements, support structures (if needed), printing time, and material necessary. All these information calculated by the slicing software is exported to ".x3g" format saved on a SD card and then sent to the 3D printer. Eventually the mathematical model becomes a tangible real life object.

Keywords: 3D printing, mathematical modelling, FDM

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Solid Modelling and 3D Printing of an Object Based on Koch's Snowflake Fractal

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Abstract

The Koch snowflake fractal is one of the earliest fractal curve, which is discovered in 1904 by the Swedish mathematician Helge von Koch. The curve first appeared in a paper titled *"On a continuous curve without tangents, constructible from elementary geometry"* [1]. The fractal can be constructed from an equilateral triangle, removing the inner third of each side, creating another equilateral triangle at the location where the side was removed. The process continues indefinitely [2]. From this basis an object generated by using a 3D solid modelling software called Solidworks [3]. Firstly, an equilateral triangle is drawn by "line" command and middle one third of the sides are removed with the" break" command. Then three smaller equilateral triangles are added to the sides where the middle parts are removed. The process is repeated until to the second iterations. Once 2D baseline fractal curve is created on the front plane, then this curve is converted to a solid body through the "Extruded Boss" command. To make the object more complex, it is twisted 180º around the Z axis by using the "Flex" command and also drafted inwards 5º along the X and Y axes to make the top end narrower and furthermore the inside of the object is hallowed with the "shell" command in order to give just 1mm thickness to the part in Solidworks.

The object in its present form is very difficult to produce with known material removing production processes. The necessity of 3D printing comes out at this point [4]. Whatever the complexity of the object 3D printing process is able to fabricate the mathematical models without having any difficulty [5]. To fabricate the object digitally a 3D printer works on Fused Filament Fabrication method is used. Preparing the 3D digital model for the 3D printing process Makerware™ slicing software is used [6].

In this study it is shown that it is possible to create a solid model using a 3D modelling software by using Koch's fractal geometrical curve. Fabricating a Koch fractal based very complex mathematical model is extremely important for providing spatial visualisation and spatial thinking ability for the students.

Keywords: Koch fractal, 3D printing, mathematical modelling, solid modelling.

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Mixed Element Modeling via Newton's Method

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Abstract

For many communications engineering applications, circuit models for measured data obtained from physical devices or subsystems is inevitable. In this work, gradient or steepest descent method is used to model physical devices using mixed lumped and distributed elements. Let us assume $S(j\omega)$ and $S_{11}(j\omega, j\tan(\omega\tau)) = \dfrac{h(j\omega, j\tan(\omega\tau))}{g(j\omega, j\tan(\omega\tau))}$ are the given and calculated reflection coefficient data, respectively. Then they must be equal ($S(j\omega) = S_{11}(j\omega, j\tan(\omega\tau))$) or very close to each other at the end of the modeling process. As a result the error can be defined as $\varepsilon(j\omega) = S(j\omega) - \dfrac{h(j\omega, j\tan(\omega\tau))}{g(j\omega, j\tan(\omega\tau))}$. Let us write module square of the error as $|\varepsilon(j\omega)|^2 = \varepsilon(-j\omega)\varepsilon(j\omega) = \left(S(-j\omega) - \dfrac{h(-j\omega,-j\tan(\omega\tau))}{g(-j\omega,-j\tan(\omega\tau))} \right)\left(S(jw) - \dfrac{h(j\omega, j\tan(\omega\tau))}{g(j\omega, j\tan(\omega\tau))} \right)$ [1].

At this step, if Newton's method is utilized to obtain the correct $h(s) = \sum_{k=0}^{n_s} h_k s^k$ values [2,3], where n_s defines the total number of elements in the two-port mixed-element network and the variable $s = \alpha + j\beta$ refers to either the variable p which is associated with the lumped elements or the variable λ which is associated with the cascaded commensurate transmission lines or UEs, then the values of the next step can be computed as

$h_{i+1}(j\beta) = h_i(j\beta) - \gamma \nabla_{h_i}\left(|\varepsilon_i(j\omega)|^2\right) = h_i(j\beta) - \gamma \dfrac{\partial|\varepsilon_i(j\omega)|^2}{\partial h_i(j\beta)}$ where γ is the step size of the process. Then the calculated values are going to be used to obtain the coefficients of the polynomial $h(s)$ via well-known linear interpolation techniques [2].

Keywords: Gradient, modeling, Newton, two-port

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An epidemiological model for the cross-species transmission dynamics of brucellosis in Turkey

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Abstract

Brucellosis is a bacterial infection that threats both humans and animals. In animals, brucellosis is transmitted by direct contact or contamination of discharges from infected individuals. Almost every case of human brucellosis has an animal origin [1]. Besides direct contact with infected animal tissues, the disease is also transmitted by eating or drinking of contaminated animal products, e.g., raw milk or cheese etc. Although Brucellosis is well controlled in most developed countries, people in developing countries are still suffering from the infection [2]. Yumuk et al. presented the seroprevalence of brucellosis in humans and animals for the officially registered cases of bovine, sheep and human populations in Turkey [1]. As brucellosis causes serious health and economic problems, the Ministry of Food, Agriculture and Livestock, Turkey has been carried out a project to eradicate the disease through vaccination of animal populations in Turkey since 2012. Unfortunately, there is no effective vaccine in use for human. In this research, we propose a mathematical model describing the cross-species transmission dynamics of brucellosis within these three populations, i.e., bovine, sheep and human. We do not take into account all transmission possibilities and focus mainly on the direct contact between individuals. Our modelling approach is based on SIR (Susceptible, Infective, and Recovered) model that is frequently used by analysing disease outbreaks [3, 4]. We also analyse the dynamical behaviour of the model and derive the stability conditions for the disease-free and the endemic equilibria. We estimate the control reproduction number and discuss the local stability of equilibria and illustrate our results by numerical simulation using the data of brucellosis collected in Turkey [1].

Keywords: Brucellosis, endemic equilibria, stability analysis

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An Implementation of Auto-Bäcklund Transformation

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Abstract

The traveling wave solutions of the combined Korteweg de Vries-modified Korteweg de Vries (cKdV-mKdV) and a complexly coupled KdV (CcKdV) equations [1-10] are obtained by using the auto-Bäcklund Transformation Method (aBTM)[5-7]. To numerically approximate the exact solutions, the Finite Difference Method (FDM) is used. In addition, these exact and numerical solutions are compared by illustrating the tables and figures. Via the Fourier-Von Neumann stability analysis, the stability of the FDM with the cKdV-mKdV equation is controlled. For the numerical solutions, the L_2 and L_∞ norm error are given. The 2D and 3D figures of the achieved singular soliton solution to these equations are plotted.

Keywords: Auto-Bäcklund transformation method; Combined Korteweg de Vries-modified Korteweg de Vries equations; Complexly coupled KdV equation; Finite difference method; Solitary wave solution.

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Proper Orthogonal Decomposition Method for the Darcy-Brinkman Equations

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Abstract

Double-diffusive convection drives a flow with two potentials that have different diffusion rates. The physical model uses that momentum is forced by both heat and mass transfer, and a Darcy term accounts for the porous boundary. As is the case with all multiphysics flow problems, simulation of the double-diffusive system can be very expensive, and thus practitioners need efficient methods to approximate solutions. One efficient method is reduced order modeling (ROM) using proper orthogonal decomposition (POD). For problems where many similar problem scenarios need tested, e.g. in an engineering design process, this method is highly efficient and has been found to be successful for many different types of flow problems [1-5].

We extend the POD-ROM to flows governed by double diffusive convection. We propose a reduced model based on proper orthogonal decomposition, present a stability and convergence analyses for it, and give results for numerical tests on a benchmark problem which show it is an effective approach to model reduction in this setting.

Keywords: proper orthogonal decomposition, double-diffusive, reduced order models.

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A Game Theoretical Approach for The Emergency Evacuation

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Abstract

Events such as fire, bomb attacks, explosion etc., in a building always threaten human lives; in this process evacuation of humans from the hazardous areas is a major and complex issue especially the buildings containing large crowds. Many factors may affect the final outcome and inefficient evacuation can be result in a large number of casualties and losses of property. The ability to evacuate people quickly and accurately in buildings is critical to the success of building emergency response operations and can potentially contribute to the reduction of various building caused casualties and injuries [1, 2]. In the last decades, the importance of emergency management has increased owing to the changed security conditions worldwide, which has led to the necessity of computer-aided emergency assessment process for extreme situations [3]. Evacuation theories of the movement and behavior of a crowd during egress could reduce the possibility of crowd disaster and could lead to minimal evacuation time and safer evacuation. Hence, it is important to study the evacuation flows through game theory applications in order to provide safe and better evacuation from buildings [4, 5, 6].

This paper investigates explores the use of cooperative game theory to model exit decisions for egress choices found in evacuations and presents a game theoretical model to optimize features of emergency evacuation planning. Network flow techniques are investigated to find good exit selections for evacuees in an emergency evacuation. At the end of the study, it is seemed that building evacuation is convenient for everyone and very accessible by using various game theory approaches. Insomuch as the paper turns into highly relate to the building map and the simulation scenario.

Keywords: Evacuation, buildings, cooperative game theory, network flow techniques.

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Optimization for Supply Chain Planning After Disasters with Cooperative Game Theory under Uncertainty

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Abstract

The frequency of disasters, whether natural or human-made, has increased to an unprecedented level in the last decades. The number and impact of disasters seems to be increasing depending on this emergency relief which gain importance day by day [1, 2]. In particular, logistics planning is the core of every relief operation. To decrease human losses, a sufficient amount of commodities must be distributed after a catastrophe within some time limit. A critical challenge is to transport sufficient essential supplies to affected areas in order to support basic living needs and commodities for those trapped in disaster-affected areas. Commodities such as food, shelter and medicine must be sent from the supply center to the affected area as quickly as possible to support rescue operation and help wounded people. This process is emergency relief.

Commonly, the emergency relief is organized by the government. The components in emergency relief involve the disaster events, the destroyed places, the wounded people, the supply and transport of commodities, and the means and environments of transport, which consist of a complex system. The timely and correct decisions in this system are critical to rescue the people and reduce the effects of the disaster [2].

The methodology of this paper is based on emergency logistic planning after disasters and fundamentals of cooperative game theory under uncertainty. To do this an interval cooperative game model is constructed from a flow problem which occurred after an earthquake in Izmir, Turkey. Some solution concepts are given for maximizing the transferred commodity. In contributing to the existing studies in this domain [4, 5], the paper proposes a possible model under uncertainty. For the supply chain dynamics domain, the results of this study may be of interest to both academics and practitioners.

Keywords: Cooperative Game Theory, Uncertainty, Flow Problem, Emergency Logistic Network, Supply Chain Management, Earthquake

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Discrete Adomian Decomposition Method for Fractional Difference Equations

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Abstract

In the present article, the discrete Adomian decomposition method(DADM) is applied to solve fractional partial difference equations. The efficiency and accuracy of this method is illustrated by test problems. The results expose that DADM is efficient, accurate and can be applied to other fractional difference equations.

Keywords: Discrete Adomian decomposition method, fractional order, partial difference equations

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Discrete-Time Control of Fractional Dynamic Systems

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Abstract

The stability of the dynamic systems is improved by the controllers' usage. One of the most commonly utilized controllers is the Proportional Integral Derivative (PID) controller. The PID controller is widely used in industrial feedback control systems. The PID controller is introduced as continuous-time control form or discrete-time control form. Most of the controlled integer systems are controlled by the continuous-time PID controller. In order to increase their stability, the PID controller is also applied to the fractional dynamic systems. In this study, the discrete-time PID controller is applied to a damped vibrating variable-order fractional dynamic system. The considered system is modeled based on Kelvin-Voight fractional derivative model. The damped fractional term in the model is represented by the Caputo Fabrizio fractional derivative. The system responses which are obtained by using numerical and discretization techniques are controlled by the discrete-time PID controller. The responses of the system are investigated for different system parameters and controller gains. A comparison between the uncontrolled and controlled responses for both classical integer model and fractional model is done. Based on the investigation and analysis of the obtained integer and fractional systems' responses, the feasibility of the introduced technique is verified.

Keywords: Discrete-time PID controller, Kelvin-Voight fractional model , Caputo Fabrizio fractional derivatived , Fractional dynamic system.

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Stability of Mechanical Systems Containing Fractional Springpot Elements

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Abstract

The aim of our contribution is to investigate the stability of equilibria of mechanical systems containing fractional springpot elements using Lyapunov functionals.

In the first part we use the infinite state representation of the fractional Caputo and Riemann-Liouville derivative, as introduced in [1-3], to obtain the potential energy of time-fractional springpot elements. More specifically, we consider fractional constitutive equations and identify springpots as uncountably infinite-order connections of springs and dashpots. The potential energy of the springs in this representation may then be interpreted as the potential energy of a springpot.

Furthermore, we interpret mechanical systems with springpots as first order systems of time-delay or functional differential equations (FDEs) instead of fractional differential equations. We use the associated stability theory of FDEs [4-6] to investigate the usefulness of the total mechanical energy of systems to establish Lyapunov functionals and examine stability of equilibria. In particular, we consider a single degree-of-freedom mass-spring-springpot system and, with the help of the associated energy functional and an invariance principle, prove asymptotic stability of the trivial solution. Moreover, we examine the influence of an additional viscous damper on stability. For a positive damping parameter, the trivial solution remains stable, as expected. In the more interesting case, choosing a negative damping parameter, stability may only be achieved under certain conditions. Numerically, we determine a critical negative damping parameter for stability and try to find a Lyapunov functional that yields sufficient conditions on the parameter for stability.

Our long-term aim is to generalize our approach to more complex and nonlinear systems.

Keywords: fractional calculus, time-delay mechanical systems, functional differential equations, Lyapunov stability.

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Imaging Anisotropic Conductivity with Induced Current Magnetic Resonance Electrical Impedance Tomography (ICMREIT)

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Abstract

In gradient coil based induced current magnetic resonance electrical impedance tomography (ICMREIT), gradient coils of a conventional magnetic resonance imaging (MRI) scanner are excited with time varying waveforms embedded in an MRI pulse sequence [1], [2], [3]. As a result of the excitation, low frequency (LF) eddy current is induced in the volume conductor media being imaged which accumulates phase to MR signal. By measuring and post-processing the LF phase of the eddy current, LF conductivity images are reconstructed [1], [2], [3]. In [1], ICMREIT is experimentally realized with by excitation of the slice selection (z) gradient coil of a clinical MRI scanner and conductivity images of phantoms with isotropic conductivity are satisfactorily reconstructed. However, biological tissues have anisotropic conductivity distributions. In order to reconstruct anisotropic conductivity distributions, coils with linearly independent primary magnetic fields are required. In ICMREIT, phase encoding (y) gradient coil of an MRI scanner can also be used in addition to the z-gradient coil. In this study, we demonstrate numerical models including the z and y-gradient coils of an MRI scanner and a cylindrical volume conductor. We utilize distinguishability analysis in order to compare the abilities of z and y-gradient coil based ICMREIT systems to differentiate conductivity perturbations from the background [3]. We propose a conductivity image reconstruction algorithm and reconstruct conductivity images by using simulated and physical measurements obtained for a cylindrical volume conductor including an inhomogeneity. The results of the distinguishability analysis, the simulation and the experimental results show that utilizing the z-gradient coil is advantageous than using the y-gradient coil.

Keywords: Induced current magnetic resonance electrical impedance tomography, gradient coil, distinguishability analysis.

Acknowledgements

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On Function Theory for Q-holomorphic Functions

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Abstract

In this work, a function theory for the generalized Beltrami systems which arise from the reduction of general elliptic systems to a standard canonical form developed similarly to complex function theory.

Keywords: Q-holomorphic functions, Beltrami systems, Elliptic systems

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Modified Exponential Type Estimators for Population Mean in Stratified Random Sampling: An Application on the Geometric Distributed Aftershocks

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Abstract

Sample surveys play important role in social sciences and interdisciplinary researches [1, 2]. There have been many studies on ratio, product estimators for the population mean in the literature [3-6]. In this paper, a new exponential type estimator for the population mean of the study variable having the geometric distribution is proposed in the stratified random sampling using the auxiliary variable information. In order to evaluate the efficiency of the proposed estimator, we first review many estimators in literature and study the optimum properties of the suggested strategy. To judge the merits of the suggested class of estimators over the others under the optimal condition, a real data application is conducted using the geometric distributed aftershock series in Turkey. The results show that the proposed estimator is more efficient than the available estimators in the stratified random sampling design.

Keywords: Stratified random sampling, mean square error, efficiency

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Existence and Uniqueness Results for a Nonlinear Differential Equation with Non-Continuous Right-Hand Side

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Abstract

Fractional calculus is a powerful tool to model many physical and engineering phenomena (see [2], [5]). As a result of mathematical modelling of these phenomena we often face with the initial-value and boundary-value problems involving differential equations of fractional or integer order. The most important one among the subjects related to the arising problems is about the existence and uniqueness of the solutions of these problems. For example, many researchers (see [3]) have been investigated the existence and uniqueness of solutions of

$$ {}^{RL}_{0}D^{\alpha}u(x) = f(x,u(x)), $$

with various initial conditions, where $\alpha > 0$ and ${}^{RL}_{0}D^{\alpha}$ is well-known Riemann-Liouville derivative defined by

$$ {}^{RL}_{0}D^{\alpha}u(x) = \frac{1}{\Gamma(n-\alpha)}\frac{d^n}{dx^n}\int_0^x \frac{u(t)}{(x-t)^{n-1+\alpha}}dt, (n-1<\alpha<n) $$

In this study, we show the existence and uniqueness of local continuous solutions of the above equation with $0<\alpha<1$ and $u(0)=b\neq 0,$ which considered by Laksmikantham and Vatsala [5], Şan [6] and Zhang [7], when $f(x,t)$ is not continuous on $[0,T]\times$ ¡ . Moreover, we obtain an estimate for the existence interval of the continuous solutions of the problem in question. For almost all results we obtained, we use new techniques involving mean-value theorem for Riemann-Liouville derivative and appropriate fixed point theorems.

Keywords: Fractional differential equations, Riemann-Liouville derivative, existence and uniqueness

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Modeling Just-in-Time distribution in a Green supply chain

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Abstract

The right-on-time distribution of goods to the end-users plays an important role in nowadays competitive market. However, companies are under pressure by protective legislations and regulations to decrease environmental footprint of their business. Companies intend to find the balance between organizational cost and environmental footprint, which is a challenging practice, as these objectives are usually conflicting. In this context, from a practical point, managers are willing to find a good compromise solution to both satisfy economic and environmental goals while they need to make sure that the products are delivered right-on-time to the demand point, thereby reducing inventory costs. This study aims to research the inter-relationship between holding inventory at warehouses and retailers to satisfy the demand right-on-time, and its impact on costs and carbon emissions. Three echelon distribution network consisting of manufacturers, warehouses and retailers is developed and three objectives; i.e., total distribution and manufacturing cost, total carbon emission associated with storing and handling of goods at warehouses and retailers, and the sum of backordered goods from retailers and surpluses of goods at retailers, are considered. As the different objective functions come with different units in this case, we adopted a fuzzy weighted additive approach, developed by [1] to reduce multi-objective optimization function into a simple weighted additive model through achievement functions and the weights of each individual objective function are determined by Analytic Hierarchy Process (AHP). Although the solution to multi-objective optimization problem consists of a set of solutions, from a practical point, the practitioners need to find only one solution. The developed model tested using a real-data obtained from a wholesale company based in Ankara, Turkey. It is found that excessive inventory held at warehouses and retailers increase the total cost and carbon emission, on the other hand, it increases the Just-in-time capability of retailers.

Keywords: multi-objective optimization, p-median, fuzzy weighted additive solution approach, Analytic Hierarchy process

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Bi-objective Closed Loop Supply Chain with Different Machinery Options

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Abstract

Since the beginning of globalization age, Supply Chain Management (SCM) has continued to attract increasing attention of academics and practitioners for decades. In recent years, SCM's focal point has begun to emerge as a sustainable flow management, in which economic, social and environmental aspects such as energy consumption, carbon emissions are jointly addressed, rather than just the flow optimization of materials on the business network extending from raw material suppliers to final consumers. In this manner, supply chain design network design decisions have now started being taken into consideration together with the environmental and economic concerns. This study focused on formulating and solving a multi-objective mixed integer linear programming mathematical model for optimization of a multi-period closed loop supply chain network design problem. The model determines the production and distribution allocation strategies, while minimizing two objectives simultaneously; the total supply chain cost and the carbon emissions generated by plants operating through different machinery types. While the initial purchase cost of older and more outdated machinery is lower than newer and updated machinery's, older machinery emits greater amount of carbon per hour as opposed to newer machinery while operating at even greater cost per hour. Besides, the number of products produced in an hour, i.e. the productivity, is also superior in newer machinery. Initial cost, operating cost, productivity and carbon emission rates available for processing products on each machine centers. We adopted a fuzzy weighted additive approach, proposed by [1], to reduce bi-objective optimization function into a simple weighted additive model through achievement functions. The results confirm that investing in newer technologies in manufacturing comes with great result for both economic and environmental causes, reducing the unit cost and carbon emission per product throughout the manufacturing periods.

Keywords: Closed loop supply chains, green optimization, energy options, carbon emissions, multi-objective optimization.

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Mathematical Behavior of Solutions of Hyperbolic-type Equations

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Abstract

In this talk, we consider hyperbolic-type equations with nonlinear damping terms. We established the existence, energy decay and blow up of solutions for hyperbolic-type equation. The hyperbolic and parabolic types equations is evolution equations. Evolution equations, namely partial differential equations with time t as one of the independent variables, arise not only from many fields of mathematics, but also from other branches of science such as physics, mechanics and material science. The interaction between damping and the source term makes the problem more interesting. Levine [1], first studied the interaction between the linear damping and source term by using Concavity method. But this method can't be applied in the case of a nonlinear damping term. Georgiev and Todorova [2] extended Levine's result to the nonlinear case. They showed that solutions with negative initial energy blow up infinite time. Later, Vitillaro extended these results to the case of nonlinear damping and positive initial energy [3].

Keywords: Existence, energy decay, blow up.

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Numerical Simulation of Hypersonic Flow over Double Ellipse Configuration with Multi-grid Accelerated and Cartesian Based Flow Solver

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Abstract

In this study, effectiveness of Cartesian based flow solver [1] is tested on hypersonic flows. A blunt body test case suggested by Désidéri et al. [2] is selected as the case study. The problem is called "Double (Simple) Ellipsoid" configuration at Reynolds number of 16.7 million, Mach number of 8.15 with 30° angle of attack. Pressure coefficient distribution around the configuration is obtained by using Liou's Advection Upstream Splitting Method (AUSM) [3] and approximate Riemann solver of Roe [4]. Solution adapted solutions are employed for both inviscid and laminar test cases whilst turbulent case (with Spalart Allmaras turbulence model as the closure of the Reynolds averaged Navier Stokes equations) is solved without solution refinement for convergence issues. Accurate solutions of these schemes for inviscid, laminar and turbulent flow assumptions are developed over two-dimensional double ellipsoid configuration. Convergence rate of the flow solver is increased by multi-grid method. Three stage multistage time stepping is used for all cases in order to increase convergence rate further. They converge around 10^{-8} density residual. Results are compared with studies of Satofuka et al. [5], Narayanarao and Mohamed [6] and He et al. [7]. Both bow nose shock and sharp canopy shock are successfully and smoothly captured by the flow solver. Mach number contours around the configuration are successfully simulated, changing between 0.2 and 8.1. Future studies are (1) to develop the Cartesian based flow solver to find heat flux change around blunt bodies under hypersonic flow conditions and (2) to simulate the same study in three-dimensional Cartesian based flow solver.

Keywords: Hypersonic flow, double ellipse configuration, multi-grid acceleration, Cartesian grid

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Mathematical Modelling of a Glaucoma Drainage Device Testing Apparatus

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Abstract

Glaucoma is an eye disruption that come up with damaged optic nerve over time due to a sustained elevation of the intraocular pressure (IOP). It is predicted that over 11.1 million people will be bilaterally blind from primary glaucoma in 2020 [1]. Glaucoma can be treated by one of the following means: Medical therapy, surgical treatment and glaucoma drainage device (GDD). Although none of these methods give thoroughly acceptable results, GDD has lead to gradual success rates with design improvements in the last decade [2].

Experiments must be devised to investigate the flow behavior inside GDDs. Before in-vitro performance testing of actively employed GDDs, microfluidics experimental setup should be modelled and the necessity of this novel test rig for currently employed GDDs should be clarified. In this study, a mathematical model of a novel GDD testing apparatus is employed and the pathway from microfluidic control unit to sealed test box is depicted.

Following steps are utilized for the mathematical model: (1) It can be easily estimated which model is compatible for any microfluidic fluid flow by calculating Knudsen number (Kn) [3]. It is found to be smaller than 10^{-3} that is much lower than the no-slip condition threshold value of Kn = 0.1. Thereby the flow characteristic is compatible with Navier-Stokes equations with no-slip boundary conditions. (2) Hagen-Poiseuille equation is used for circular cross-sectional parts of the setup and Reynolds number (Re) is 0.17 for the designed setup with entrance length of 0.606. Since Re is smaller than unity, the flow characteristic is called as creeping flow [2] in which viscous forces becomes dominant. (3) The pathway of fluid flow is modelled and pressure losses in specific sections of the pathway, namely entrance loss, loss due to the pipe flow, losses due to sudden enlargement, losses due to GDD body, losses due to GDD to pipe outlet are all taken into consideration. For a specific case of Ahmed GDD [2], the pressure losses through them are calculated to be 1188.92 Pa in total.

Keywords: Glaucoma drainage device, microfluidics experimental setup, mathematical modelling

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Time-varying pharmacodynamics in a simple non-integer HIV infection model

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Abstract

In this paper we study the effect of time-varying drug exposure in the dynamics of a fractional order model for HIV infection. We compute the reproduction number of the model and verify the stability of the disease-free equilibrium. The model is simulated for parameters directly modeling the pharmacodynamics of HIV, namely the slope of the dose-response curve, the drug's half-life, the dosing interval. The later affect in a significant way the infection patterns. The order of the fractional derivative is also a key player of the model, adding more information, which could be useful for a deeper understanding of the pharmacodynamics of HIV.

Keywords: *time-varying drug efficacy, pharmacodynamics, HIV, fractional model*

Acknowledgements

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Maintenance of the latent reservoir by pyroptosis and superinfection in a fractional order HIV transmission model

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Abstract

We focus on the importance of pyropstosis and superinfection on the maintenance of the latent reservoir on HIV infected patients. The latent reservoir has been found to be crucial to the persistence of low levels of viral loads found in HIV-infected patients, after many years under successful suppressive anti-retroviral therapy (ART). This reservoir seems to act as an archive for strains of HIV no longer dominant in the blood, such as wild-type virus. When a patient decides to quit therapy there is a rapid turnover and the wild-type virus re-emerges. Thus, it is extremely important to understand the mechanisms behind the maintenance of this reservoir. For that, we propose a fractional order model for the dynamics of HIV, where pyroptosis and superinfection are considered. The model is simulated for biological meaningful parameters and interesting patterns are found. Our results are interpreted for clinical appreciation.

Keywords: *latent reservoir, pyropstosis, superinfection, HIV, fractional model*

Acknowledgements

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Decentralized Stochastic Control: Optimality and Approximations

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Abstract

In this work, we consider existence and approximation of optimal control policies in decentralized stochastic control problems. In the first part of this work, we consider the existence of team optimal policies for static teams and a class of sequential teams. The existence result will be established via two approaches: In the first approach, the existence of team optimal policies is shown by introducing a topology on the set of policies [1], whereas in the second approach, we prove the existence of team optimal policies by considering a dynamic programming formulation of decentrized control problems [2,3]. In the second part of this work, we consider finite model approximations of a large class of static and dynamic team problems where these models are constructed through uniform quantization of the observation and action spaces of agents. The policies obtained from these finite models are shown to approximate the optimal cost with arbitrary precision under mild technical assumptions [4]. These existence and approximation results are then applied to the celebrated Witsenhausen's counterexample and the Gaussian relay channel.

Keywords: Decentralized control, team decision theory, existence and approximation of optimal team policies.

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An Application for Sharma-Tasso-Olver Equations by Using Auto-Bäcklund Transformation

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Abstract

In this application, with the help of Mathematica software, the auto-Bäcklund transformation method (aBTM) and the finite forward difference method are used for obtaining the travelling wave solutions and the numerical and exact approximations to the Sharma-Tasso-Olver (STO) [1-6] equation respectively. We successfully obtain some kink-type solutions with exponential prototype structure to this equation by using aBTM. We then employ the finite difference method (FDM) in approximating the exact and numerical solutions to this equation by taking one of the obtained wave solutions into consideration. We also present the comparison between exact and numerical approximations and support the comparison with a graphic plot. Moreover, The Fourier von-Neumann stability analysis is used in checking the stability of the numerical scheme. We also present the L_2 and L_∞ error norms of the solutions to this equation.

Keywords: Auto- Bäcklund transformation method, Sharma-Tasso-Olver equation, Finite difference method, Traveling wave solutions.

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Explosive Solutions for a Class of Stochastic Nonlinear Wave Equation with Damping Terms

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Abstract

The wave equation $f_{tt} = c^2\tilde{N}^2 f$ is one of the most fundamental partial differential equation which arises in different fields such as electromagnetics, traffic flows, fluid dynamics, general relativity, acoustics [1]. The research efforts over the centuries, when combined with various physical, chemical and biological phenomena that had to be explained, has resulted in a tremendous body of literature on the wave equation.

Many of the systems that surround us include randomness. On account of this, the fluctuating properties of media must be included in the wave equation for a realistic model. In 1960's stochastic wave equation emerges in the investigation of various areas of physics and engineering such as quantum field theory, solid-state physics, and nonlinear optics.

In this work, we consider a class of stochastic damped wave equation with weak and strong damping terms. For the deterministic case, in the absence of damping terms Cauchy problem for the wave equation considered here is known to have solutions locally in time if nonlinear term satisfies some local Lipschitz conditions, and for some particular nonlinear terms there exist solutions blowing up in a finite time [2,3,4].

In the present work, we investigate the effect of stochastic terms on the blowing up or explosion of solutions. By using the energy inequality we prove that solutions of the problem blow-up in finite time with a positive probability or are explosive in the L^2 sense.

Keywords: Stochastic wave equation, Blow up, Energy inequality.

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Multivalued F-contraction on M-Metric Space

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Abstract

In 1922, Banach [1] proved very fundamental theorem which is known as Banach contraction principle. Because of its applicability and importance, many authors studied to generalize this result. In different way, Nadler [2] generalizes Banach contraction principle to case of multivalued mappings. After Nadler, many author studied fixed point theorems for multivalued mappings on metric space and other abstract spaces [3,4,5]. Feng-Liu [6] generalizes Nadler's theorem without using Pompei-Hausdorff metric. Moreover, Feng-Liu used that the mapping is nonempty closed subset valued instead of nonempty closed bounded subset valued in their result. Recently, Asadi et al. [7] introduced concept of M- metric space and studied fixed point theorems for single valued mappings on M-metric space. Afterwards, Altun et al. [8] discussed on the topological structures of M-metric space and then taking into consideration the family of all nonempty closed subsets of a M-metric space, obtained some fixed point theorems for multivalued mappings of Feng-Liu type on M-metric space. On the other hand, Wardowski [9] generalizes Banach contraction principle by introducing definition of F-contraction. We consider Feng-Liu type fixed point theorem and F-contraction with together, In this way, we generalizes results in the literature. Finally, we give illustrative examples.

Keywords: Fixed point, F-contraction, M-metric, multivalued mapping

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Optimal Control of Generalized Tumor Growth Model with Chemotherapeutic and Immunotherapeutic Treatment

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Abstract

Cancer is a disease caused by abnormal cell growth in the body and about half a million cancer deaths are reported every year. Therefore, in order to investigate the disease mathematically, we construct a fractional order cancerous tumor growth model which expresses the interactions between tumor and immune cells [1]. We present an optimal control strategy to eliminate the number of tumor cells while minimizing the amount of chemotherapeutic and immunotherapeutic drugs in the system [2]. We investigate the equilibrium points and discuss their stability. Numerical simulations are performed for different values of the parameters in the model. We find out the best treatment strategy to eliminate the tumor cells in the system over a specified time interval.

Keywords: Optimal control, cancer, chemotherapy, immunotherapy, fractional calculus.

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Identifying the Important Criteria for Determination of Temporary Debris Storage Sites By Using Analytic Hierarchy Process (AHP)

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Abstract

Disasters can lead to a high risk of casualties and structural damages. Destructive disasters, such as earthquakes, may cause a great amount of disaster waste to be controlled. Debris management is one of the most important and complicated activities among post-disaster operations. A substantial amount of waste is typically generated from disasters. The debris generated from affected communities can be as high as 5–15 times the normal annual rate. In addition, the clearance, removal and disposal of debris from disasters is difficult, time-consuming, and expensive. Processing of debris such as decomposition, reusing and recycling can be made in temporary debris storage sites (TDSS) like the ones suggested by the United Nations and the United States Federal Emergency Management Agency guidelines on disaster waste management. TDSS play multiple roles within the whole system. Firstly, they can provide a buffer and space by hauling debris from the disaster affected community to the TDSS. Secondly, operations such as chipping, burning, and sorting can be done at the TDSS to reduce the amount of waste as well as preparing for recycling and reuse. Finally, they can act as temporary storage places before the final disposal of debris. Also, reusing and recycling materials in the debris can decrease the need for re-construction resources. The objective of this study is to identify the important criteria for determination of temporary debris storage in order to select best site with providing flexibility, easiness and fastness in disaster management activities. Therefore, criteria about TDSS and solid waste landfilling are analyzed in literature and 8 main criteria and 26 sub criteria related to them are formed. Then, proposed criteria about TDSS are evaluated by experts from Disaster and Emergency Management Authority (AFAD). The importance degree of main and sub criteria are computed using AHP method with the help of EXPERT CHOICE program. The results obtained show that environmental criteria, criteria about safety and site characteristics have the highest importance level among the others, however criteria about cost, location and logistics have the lowest importance level.

Keywords: Temporary debris storage sites, multi-criteria decision making, AHP

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A New Spread Spectrum Audio Watermarking Technique: Improved Robustness and Increased Capacity Using Moving Average

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Abstract

Steganography is the art of information hiding. The main purpose of steganography is to transfer data securely in an invisible way while information is visible but unreadable in cryptography. Steganography techniques were used for secret communication for ages, however these techniques have appeared to be very useful for digital watermarking. Signature of owner, which proves copyright information, can be hidden into digital files such as image, audio or video using steganography techniques.

It is easier to hide information in digital images comparing to digital audio since human auditory system is more sensitive than human visual system. Small changes in audio signals are recognized by ear easily. So, there are fewer studies on digital audio steganography and watermarking. Least Significant Bit (LSB) Coding, Parity Coding, Phase Coding, Quantization Index Modulation, Echo Hiding and Spread Spectrum methods [1-4] are some of data hiding methods in audio steganography.

In this study, we have examined statistical properties of audio signals in audio watermarking. As a result, we have improved robustness and capacity of spread spectrum audio steganography method using moving average by processing the cover audio in both the forward and reverse directions. On the other hand, we have practiced data hiding process by generating mixer signals using sinusoidal modulation between adjacent segments in order to smooth transition of data bits. We have chosen embedding coefficient as variable depending on energy level of each segment to improve inaudibility of hidden information. In conclusion, we have achieved %99.96 correct bit rate in our experiments against various lossy audio compression standards such as MPEG-1 Audio Layer III (MP3), OGG and FLAC. Furthermore, payload capacity is increased up to 90 bps.

Keywords: Audio Watermarking, Spread Spectrum, Signal Processing, Moving Average, Sinusoidal Modulation

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Determination of Suitable Alternative in Facility Layout Problem Considering Different Criteria

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Abstract

Facility layout is the locating of physical resources such as labor, materials, machinery and equipment used in the production of goods or services by providing the desired capacity, quality, cost and ergonomic conditions in an efficient way. It is an approach that integrates many factors, such as inventory control, material storage, scheduling, routing, dispatching, to meet production objectives. Therefore, it has a significant effect on the performance of production or service systems. Many studies on facility layout consider some factors such as effective usage of the layout, reduction of all movements for products, increase the productivity of system, flexibility for production, and ease of planning. In this study, it is planned to rearrange the existing layout due to the problems of increasing demand in a company which is operating in the defense industry. With increased demand, areas for departments remain fixed, but the movement of employees become very limited because the capacities of the departments are increased. Consequently, an additional block is built for moving some parts of the departments and the remaining parts are rearranged. At first, ALDEP from computer aided algorithms is used to generate several layout alternatives for remaining departments. Then, five different criteria have been identified with the help of experts in company to select the most appropriate layout from alternatives. The importance degree of criteria are determined by AHP (Analytic Hierarchy Process) method and supported by expert opinions. Finally, PROMETHEE (The Preference Ranking Organization Method for Enrichment Evaluation) method is used to select 10 proposed layout alternatives according to criteria. Also, a sensitivity analysis is made to measure effect of the importance degree of the criteria in the selection of alternatives.

Keywords: Facility Layout, multi-criteria decision making, AHP& PROMETHEE

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A Numerical Approach for Solving Burger-Fisher Equation with Variable Coefficients using Laguerre Polynomials

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Abstract

Burger-Fisher equation is a particular class of nonlinear partial differential equations and arises in applied mathematics and physics applications such as financial mathematics, gas dynamics, traffic flow, fluid dynamics, turbulence and shock wave formation, convection effect, diffusion transport or interaction between the reaction mechanisms. In this study, we consider Burger-Fisher equation with variable coefficients defined by

$$\frac{\partial u}{\partial t}-\frac{\partial^2 u}{\partial x^2}+\beta(t)u\frac{\partial u}{\partial x}=\alpha(t)u(1-u)$$

with initial or boundary conditions where $\alpha(t)$ and $\beta(t)$ are arbitrary functions of t. In order to solve this problem, we present a different numerical approach, called matrix-collocation method based on Laguerre polynomials. The method reduces the solution of the nonlinear equation to the solution of a matrix equation corresponding to system of nonlinear algebraic equations with the unknown Laguerre coefficients. Thereby, the approximate solution of the problem is obtained in the truncated Laguerre series form. Also, some illustrative examples along with an error analysis based on residual function are performed to demonstrate the validity and applicability of the method; the results are discussed.

Keywords: Nonlinear partial differential equation, Burger-Fisher equation, Laguerre matrix-collocation method

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High Order Galerkin Method for the Advection Diffusion Equation

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Abstract

We consider the following one dimensional advection-diffusion equation

$$u_t + \alpha u_x - \mu u_{xx} = 0,\ a \le x \le b \tag{1}$$

with the boundary conditions

$$\begin{matrix} u(a,t) = u(b,t) = 0 \\ u_x(a,t) = u_x(b,t) = 0 \end{matrix} \quad ,t \in [0,T] \tag{2}$$

and initial condition

$$u(x,0) = f(x),\ a \le x \le b \tag{3}$$

in a restricted solution domain over an space/time plane $[a,b]\times[0,T]$. In the one dimensional linear advection-diffusion equation, α is the steady uniform fluid velocity, μ is the constant diffusion coefficient and $u = u(x,t)$ is a function of two independent variables t and x, which generally denote time and space, respectively. The advection-diffusion equation (sometimes called the convection-diffusion equation) is the basis of many physical and chemical phenomena, and it is a one dimensional parabolic partial differential equation which illustrates advection and diffusion of quantities such as mass, energy, heat, vorticity etc. In the equation, u_x and u_{xx} are advection and diffusion terms, respectively. In many environment problems, $u = u(x,t)$ also represents concentration of the pollutant or contaminant material at point x at the time t. A variety of special algorithms have been proposed in recent years dealing with getting the numerical solution of one dimensional advection-diffusion equation so far [1-4]. In this study, sextic B-spline Galerkin finite element method, based on second, third and fourth order single step methods for time integration is proposed for numerical solution of the advection diffusion equation. Two test problems modelling the transportation of a concentration and distribution of an initial pulse are studied and accuracy of the numerical results is measured by the computing the rate of convergence and error norm L_∞ for the proposed algorithm. The numerical results of this study demonstrate that the proposed third and fourth order single step methods are remarkably successful numerical techniques for solving the advection-diffusion equation.

Keywords: Advection diffusion equation, Galerkin finite element method, Sextic B-spline

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Numerical Solutions of the Nonlinear Klein-Gordon Equation through a Compact Finite Difference Scheme

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Abstract

This study aims at numerically solving the nonlinear Klein-Gordon equation, which is the basic evolution equation in relativistic field theory, using a sixth-order compact finite difference (CFD6) scheme. The proposed method is applied for discretizing spatial derivatives and then third-order strong stability preserving Runge-Kutta (SSP-RK3) technique is used for the time integration of the resulting system. Some test problems having exact solutions are considered to analyze the applicability and efficiency of the proposed method. The performance of the method is measured by some error norms. The suggested method is seen to be applicable, effective and easy to use. Furthermore, it is also seen that the method is of high order accuracy with less grid points.

Keywords: Klein-Gordon equation, compact finite difference scheme, strong stability preserving Runge-Kutta

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Soft Quasi Metric Spaces and Some Notes on Soft G-Metric Spaces

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Abstract

Problems in many fields involve data that contain uncertainties. To overcome these difficulties, Molodtsov [6] introduced the concept of soft set as a new mathematical tool for dealing with uncertainties that is free from the difficulties. In [6,7], Molodtsov pointed out several directions for the applications of soft sets, such as smoothness of functions, game theory, operations research, Riemann-integration, Perron integration, probability, theory of measurement and so on. At present, works on soft set theory and its applications are progressing rapidly. The help of rough mathematics of Pawlak [10], Maji et al. [5] defined a parameter reduction on soft sets, and presented an application of soft sets in a decision making problem. Das and Samanta [1] presented the notions of soft real set and soft real number and gave their properties. In 2005, Mustafa and Sims introduced a new class of generalized metric spaces (see [8],[9]) which are called G-metric spaces, as generalization of a metric space (X, d). Subsequently, many fixed point results on such spaces appeared. In 2012, Jleli and Samet [4] established the concept of quasi metric spaces and they showed that the most obtained fixed point theorems on G-metric spaces can be deduced immediately from fixed point theorems on metric or quasi metric spaces. In this paper, we introduce the notion of soft quasi-metric space, according to soft element and define some of its properties. Also we will give connections among soft metric, soft G-metric and soft quasi-metric. And then, we indicate that the most gotten fixed point theorems on soft G-metric spaces can be concluded directly from fixed point theorems on soft metric or soft quasi-metric spaces. Thus we conclude that the main results of very recent papers of Guler, Yildirim and Ozbakir [2] and Guler and Yildirim [3] are consequences of the main result of this paper.

Keywords: fixed point, soft metric space , soft G-metric space, soft quasi metric space

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Ln Type Estimators under Stratified Random Sampling

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Abstract

Many authors have suggested various estimators for the population parameters by using the information of the auxiliary variable, such as ratio, product, regression, and exponential type estimators in sampling theory literature for the last 3 decades. In this article, we introduce to use the ln function for the first time in literature to improve the efficiency of the estimator for the population variance in the stratified random sampling. We derive equations of the mean square error (MSE) and bias using the Taylor series method, up to first order approximation, and find the efficiency conditions for the proposed estimators. Moreover, we consider three different sets of data in the numerical example and a simulation study using the real data set to show that the proposed ln type estimators are better in estimating the population variance.

Keywords: Ln type estimator, mean square error, separate method, variance estimator.

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Modeling of Breast and Gynecological Cancers Data and Investigating New Biological Findings

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Abstract

The breast and gynecological cancers are two most common fatal cancers' types in women in the world [1]. In oncological literature, these two cancers types are typically worked together since they are the risk factors of each other if the patient has one of these diseases [2]. In general, the cancers, like the heart diseases, are the systems' ilnesses in the sense that any malfunctions in the associated transaction pathways cause problems in the activation flow, resulting in tumors. Therefore, the mathematical representation of these complex structures enables us to better understand the actual biological process and to produce the target drug. Accordingly, in this study, we evaluate 10 different publically available datasets which are collected from the GEO database. Originally these data are the gene expression datasets where some of them also have certain descriptive information about the samples. Hereby, from each dataset, we initially generate subnetworks by selecting the most significantly expressed genes and normalize them via the RMA method [3] if they are the Affymetrix data or normalize them via deterministic background and quantile normalizations. Then, we present them via distinct mathematical models such as MARS [4] and CGGM [5] in order to describe the steady-state behaviour of the proteomic activations. Here, we evaluate the performance of every model via the accuracy of the estimates and the computational demand. Later, we also combine these models with the risk factors of each cancer and re-construct more comprehensive mathematical models. Finally, we validate our estimated systems via the associated literature and biologically discuss our new findings. By this way, we can also combine the knowledge of both cancers types under a single and more comprehensive mathematical model. We consider that our mathematical representation can open new avenue about these diseases and help us to ask biologically more interesting questions.

Keywords: Mathematical models, breast cancer, gynecological cancer, biological systems.

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Comparison of Alternative Transformations to Handle Heavily Skewed Distribution of Health Expenditures

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Abstract

Skewed distribution of expenditure variables, makes modelling health care costs and expenditures difficult. Thus, the literature offers some strategies to combat with highly skewed health expenditure variable. This study aims to compare alternative transformations to deal with positively skewed distribution of health expenditures. Data came from member of 214 World Bank countries. A multiple regression model was conducted, health expenditure per capita was used as a dependent variable, life expectancy at birth, GDP per capita, total population, unemployment rate and maternal mortality was used as covariates. National logarithm (LN), Box-Cox (B-C) transformation and Square root (SQRT) transformations was applied to the health expenditure per capita. Random Forest regression, k=10-fold cross validation was applied while changing number of trees from 3 to 61. Root Means Square Error (RMSE), Mean Absolute Error (MAE) and coefficient of determination (R2) results were recorded for three different transformation methods. Kruskall-Wallis variance analysis was used to compare prediction performances of different methods.

Study results show that, alternative transformations statistically different in terms of RMSE (X^2=76.756, p<0.001); MAE (X^2=76.837, p<0.001); R2 (X^2=59.051, p<0.001) and B-C transformation dominates others. Results of this study highlight that B-C transformation is better to handle with heavily skewed distribution of health expenditures and to improve prediction performance of the model. It is advisable for future studies to provide a light on different types of health expenditure indicators.

Keywords: Health Expenditure, Logarithmic transformation, Box-Cox transformation, Square Root transformation, Random Forest

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Ensemble Learning Methods to Deal with Imbalanced Disease Data

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Abstract

Rare events and class imbalance is very often in classification problems. Rare diseases which are good example for rare events are life-threating and vast majority of them are genetically determined. Several ensemble learning methods (ELMs) were applied to health care datasets to predict disease risks for patients. These methods are consists of a set of individual training classifiers such as Bagging and Boosting. This study aims to compare ELMs classification performances applied on thyroid disease dataset. Data came from UCI Machine Learning Repository. Diagnosed as a hyperthyroid determined as a dependent variable for classification. ID.3, C4.5, CART, NB, KNN, RF, SVM, NN were used as ELMs. Bagging and Boosting were implemented to improve prediction performances. "k" 10 fold cross validation and AUC was examined to evaluate classification performances of ELMs.

Study results reveal that single ELM have superior prediction performance compared with Bagging and Boosting applications. In addition to that kNN, RF and NN have superior classification performance compared with other ELMs. Future research is needed to better understand the role of ELM to improve prediction performance of rare disease data.

Keywords: Imbalanced Data, Rare Diseases, Ensemble Learning Methods

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A methodical model formulation for the tool path optimization problem in CNC machines: A case study

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Abstract

Nowadays, to achieve an effective and efficient production system for a company is very important due to the tough competition conditions. In this context, one of the most important factors that provide efficient production is increasing capacity utilization in operations, which directly affects factory production efficiency.

This study considers an internal operation optimization of a company producing various machine parts by using Computer Numerical Control (CNC) milling machines and aims to increase the capacity utilization rates of the CNC machines to rise up the production efficiency of the company. Factors that lead to low capacity utilization rates are determined by examining system analysis, time studies and Total Equipment Effectiveness (OEE) data within the factory. In order to improve these factors in the company, loss times in the internal processes are taken into account to be reduced. For this purpose, first, internal processes are examined on CNC milling machines and ABC analyses are made on the OEE data obtained from the company. Thereafter an optimization approach is introduced to reduce the moving path of the cutting tool in CNC milling machines. In order to make the tool path optimization, the tools used in the looms, swarf depth, swarf taking movements, empty movements are taken into consideration. The aim of the tool path optimization approach is to reduce unnecessary movements of the tool in the part machining operations by examining the existing tool paths [1-3]. To find the optimum tool path for the CNC milling machines, a mixed integer mathematical model formulation based on the travelling salesman problem concept is introduced. Distinct from the travelling salesman problem, precedence of the tool operations are considered in which the objective of the model is to minimize total idle and unnecessary times of the tool for internal operations. The proposed mathematical formulation is carried out on a problem which is one of the products of the company to be produced in the CNC milling machines. The result of the computations shows that 2% improvement on the operational times is provided with respect to existing tool path used by the company. As a consequence, it should be noted that the proposed solution approach for the tool path optimization is capable to provide considerable time reductions on the CNC internal operations for the company.

Keywords: Tool path optimization, mathematical modelling, travelling salesman problem

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A Discussion of the Generalized Abel Integral Equation

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Abstract

Abel [1,2] solved the famous tautochrone problem in 1820s, and this was the first realization of the differentiation and integration of fractional order. Generalized Abel integral equations, which may be the most well-known fractional type of singular integral equations [3-4], were studied in this research. Fractional calculus is remembered with the name of Caputo [5-6] because of his important contributions to the theory. A comprehensive source about fractional calculus can be found in [7], and references therein. In this study, we discuss the generalized Abel integral equation through an approximate approach [8-9].

Keywords: Generalized Abel Integral Equation, Generalized Binomial Theorem

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Numerical Solution of the Fredholm Integro-Differential Equation with Initial-Layer

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Abstract

The study deals with an initial-value problem for a singularly perturbed Fredholm integro-differential equation. Parameter explicit theoretical bounds on the continuous solution and its derivative are derived. The difference scheme is constructed by the method of integral identities with the use exponential basis functions and interpolating quadrature rules with the weight and remainder terms in integral form. The finite difference discretization constructs on a uniform mesh. Parameter uniform error estimates for the approximate solution are established. Numerical results are given to illustrate the parameter-uniform convergence at the numerical approximations.

Keywords: Fredholm integro-differential equation, singular perturbation, finite difference

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Capacity Planning for Support Parts for Pipe Production

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Abstract

In terms of business, the optimal capacity level should be determined and strategic business plans should be made in accordance with the determined capacity level. The wrong implementation of this plan will result in idle or inadequate capacity problems for enterprises. In this case, the efficiency of the enterprise, therefore, profitability will not reach the desired level.

The aim of this study is determining the standard time and capacity plan for all types of support that used in pipe production. In this context, determining the basic routes of product types and calculating standard times are very critical. Firstly, workflow diagrams have been created and value stream mapping has been prepared. By means of the value stream maps prepared, bottleneck processes were detected in the product flow. The second stage is to determine the standard production time. Although the types of support seem to be similar, they are divided into dimensional and shape varieties within themselves. Even small features affect the standard time of the types and this has a negative impact on the distribution of labor force. For this reason, to obtain the standard time for each type, a program has been prepared which provides the processing time of each part quickly by writing the part identification number in Excel VBA (macro) module. At the same time, it is possible to calculate the production capacity on a project basis and see how many shifts each operation will be completed in the project by using the scheduled schedules.

In this study, the number of bottlenecks, intermediate stocks and operational capacities were determined by using the pro-model program. By taking into account uncertainties and variables in these cases, capacity planning and simulation studies were carried out considering factors affecting working at full capacity. In order to meet the demand, different scenarios were run and it is determined how many operators must perform the related operation.

As a result of this study, 20.98% improvement in the production of plate type products and 6.54% improvement in support type were achieved.

Keywords: Pipe production, support, value stream mapping, capacity planning

Acknowledgement

We would like to express our gratitude to Uludağ University and Çimtaş Pipe Manufacturing Factory for enabling the realization of the project.

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A Nonstandard Numerical Approach for a Ratio-Dependent Predator-Prey Model

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Abstract

In this talk, we investigated the fixed points of discretizated predator-prey model with ratio-dependent functional response. We have used Nonstandard Finite Difference Schemes (NSFD) that preserve both the positivity of the solutions and the local stability of the equilibria of the continuous-time system. However, due to the difficulty of solving such models, the behavior of numerical solutions have been examined.

Keywords: stability analysis, ratio-dependent, nonstandard finite difference scheme .

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Stability Analysis of a Discretizated Predator-Prey Model with Beddington-DeAngelis Functional Response

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Abstract

In this talk, a continuous-time predator-prey model with Beddington-DeAngelis functional response is discretized. We have used Nonstandard Finite Difference Schemes (NSFD) for designing methods that preserve the local stability of equilibria of the approximated system. The techniques are based on a nonlocal numerical treatment of the right-hand side functions and more sophisticated discretization of time derivatives. However, the NSFD methods, guarantee positive solution for positive initial points while Standard Finite Difference methods do not guarantee the positivity for all positive initial conditions.

Keywords: Predator-Prey Model, Beddington-DeAngelis Model, Nonstandard Finite Difference Scheme .

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Numerical Modeling of Heat Fluid and Mass Transfer in Algae Cultivation Process Integrated with Ground Source Heat Pump

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Abstract

Numerical modeling of heat, fluid and mass transfer in algae cultivation process integrated with ground source heat pump at different air flow rate is studied in this research. The calculation approaches are numerically developed to reach operative conditions for extent of the cultivation essentials heat and air blown into the cultivation water abundantly adapted for the growth of algae. The temperature and air mass profile differences in the water for quasi steady state growth circumstances of the algae are elucidated in a degree of discrepancy at each time step. The study confirmed that the extent of the heat and mass sourced from the system can adequately accomplish incubation of algal biomass.

Keywords: Numerical modeling, heat, fluid and mass transfer, Ground source heat pump, algae cultivation process

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Metaheuristic Approach to Dual-Resource Constrained Job Shop Scheduling Problem

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Abstract

Both machines and human resources usually constrain the real world manufacturing systems and this type of systems are referred as Dual Resource Constrained (DRC) systems. A metaheuristic approach is proposed to solve the Dual Resource Constrained Job Shop Scheduling Problem (DRCJSP) in this study. Weighted Superposition Attraction (WSA) [1, 2] algorithm, which is based on two basic mechanisms, 'superposition' and 'attracted movement of agents' for solving complex optimization problems is presented to deal with DRCJSP. A preemptive goal programming based logic [3] is utilized to handle three objectives: mean tardiness, cost, and make-span. Benchmark problems are used to depict the performance of the proposed WSA algorithm. Extensive computational tests are presented in order to show that the proposed algorithm can improve the job shop performance in comparison to employing basic dispatching rule based approaches for the stated dual resource constrained scheduling problem. Moreover, the results of the proposed algorithm is also compared with the results of the GRASP algorithm that is presented in [4].

Keywords: Dual resource constraints, job shop scheduling, combinatorial optimization, metaheuristics

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Weighted Superposition Attraction Algorithm for Type II Two-Sided Assembly Line Balancing Problem

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Abstract

In a two sided assembly line, different assembly tasks are carried out on the same product in parallel to both left and right sides of the line [1]. A metaheuristic approach is proposed to solve two sided assembly line balancing problem (TSALB) of type II in this study. Weighted Superposition Attraction (WSA) [2,3], which is based on two basic mechanisms, 'superposition' and 'attracted movement of agents' is adopted to solve TSALB with the objective of cycle time minimization for a given number of stations. Extensive computational study is carried out and the results are compared with the results of several algorithms from the literature.

Keywords: Assembly line balancing, two-sided assembly line, combinatorial optimization

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Evaluation of Product Recovery Facilities Using Multi Criteria Decision Making

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Abstract

Stricter environmental regulations and diminishing natural resources forced many companies to set up product recovery facilities where reprocessing operations such as disassembly and recycling/remanufacturing are carried out [1]. Selection of efficient product recovery facilities has an utmost importance in the profitability of product recovery activities. The number of studies evaluating the product recovery facilities is very limited. In this study we evaluate product recovery facilities using multi criteria decision making.

Keywords: Product Recovery, Facility, Multi Criteria Decision Making

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Evaluation of Customers of a Company using Multi Criteria Decision Making

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Abstract

Effective management of customer relations is an important factor for the protection of market share in today's highly competitive business environment. In order to ensure the effectiveness of customer relations management (CRM) activities, most companies determine the most important customers and concentrate CRM activities on those customers [1]. Multiple and conflicting criteria must be considered while determining the most important customers. Hence the use of multi-criteria decision making in this area provides more objective evaluations. In this study, multi-criteria decision making is used to evaluate the customers of a company. The relationships among the criteria and the most important customers for each criterion are also analyzed visually.

Keywords: Customer Relations Management, Multi Criteria Decision Making, Market Share

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Implementation of 5S Systematic in a Hard Chrome Plating Company

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Abstract

Order and discipline are priority concepts for achieving quality in production. Through the use of 5S, which reveals this order and discipline in a systematic manner, necessary and unnecessary materials are determined and improvements are achieved in production times, employee satisfaction, and product and work-place quality [1, 2]. In this study, 5S steps are implemented in a hard chrome plating company and the obtained results are analyzed.

Keywords: 5S Systematic, Quality Improvement, Hard Chrome Plating

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Numerical Analysis of Second Order Time Stepping Methods for the Natural Convection Problems

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Abstract

Natural convection is a mechanism, in which the fluid motion occurs due to density differences in the fluid instead of any external source (like a pump, fan, etc.). Natural convection is of great importance in Computational Fluid Dynamics because of its presence both in nature and engineering applications such as the rising plume of hot air from fire, free air, cooling fluid flows around heat-dissipations fins, etc. In addition, this phenomena occurs in an increasing number of fields, including oceanography, meteorology and geophysical context [1, 2, 3]. The accurate and efficient numerical solutions of these flows are known to be the core of many applications.

The main objective of this study is to propose, analyze and test a family of second order time stepping methods for the Boussinesq system, by extending an earlier study of [4] for the Navier-Stokes equations (NSE) based on the pioneering work for [5, 6]. In this study, the idea is to incorporate linearizations and stabilization terms such that the discrete curvature solutions in velocity, temperature and pressure are proportional to this combination. The method requires the solution of only one linear system per time step. We prove unconditional stability of the method and show that it is $O(\Delta t^2)$ accurate. Also, a priori error bound is derived. Several numerical experiments are provided that support the derived theoretical results and demonstrate the efficiency and the accuracy of the method.

Keywords: Boussinesq equations, curvature stabilization, linear extrapolation, error analysis.

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A Short Review of CFD Based System Identification in Aerodynamics Applications

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Abstract

Computational fluid dynamics (CFD) is a modeling tool for flow field characterizations, calculations and predictions. Combining CFD with a grey box method in order to simulate a control system is trending with high performance computers and fast converging solutions in last decade. Modeling is the key part of linking CFD to system identification that can be realized by using CFD data of a numerical study instead of time-series data of associated experimental/industrial system.

Meng et al. [1] gave a general review of CFD based system identification (CFD-SI), in which a flowchart of off-line CFD-SI can be found. They surveyed all CFD related control system applications in literature until 2010. Two remarkable aerodynamics applications are: adaptive flow control for an incompressible viscous fluid through a two-dimensional channel using CFD simulation result data to identify the required parameters and two dimensional (2-D) pipe flow control system model, and the linear model of spacecraft propulsion control system. In last eight years, additional studies are encountered in literature using CFD model for predicting aerodynamic coefficients and flow parameters.

In this study, the focus point is determined as CFD-SI based prediction of aerodynamics, which is an almost untouched topic unlike other more common applications on premixed flames, combustion, thermo- and aero-acoustics, etc. In 2011, Meng et al. [2] studied CFD simulation in Fluent and CFD-SI model in CAPTAIN toolbox of MATLAB. They modeled a feedback control system involving a fluid flow and heat/mass transfer related process. In 2012, Erbil and Kasnakoğlu [3] presented a novel approach for the modeling and control of flow problems when the fluid viscosity is immeasurable and non-constant. In their study, wavelet transform of the flow snapshots obtained from CFD simulations track the closed-loop system successfully via D-K iteration algorithm. In 2016, Jaensch et al. [4] used plane wave masking to couple CFD and the time domain acoustic model. Their formulation works well with laminar as well as turbulent flows. This short review reveals that the literature of CFD-SI in aerodynamics applications is very immature and open to progress. As a contribution to this field, authors of current study are in preparation stage of a project on CFD-SI of microjet actuators.

Keywords: CFD, system identification, grey box method, aerodynamics

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The Qualitative Behavior of Some Stiff ODEs Through Stochastic Methods

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Abstract

In the last few decades, an effectively created model for systems involving random elements has highly taken attention from academic societies since behaviors in the real life cannot been explained by only one input variable. It is believed that stochastic methods are generally used for solving stochastic models [1-2]. However, these methods can also be used in dealing with deterministic models [3-5]. This study aims at analyzing how deterministic problems can be considered by stochastic approaches. Thus, an algorithm based on the Monte Carlo approach has been presented for solving some stiff ordinary differential equations [6]. To properly realize the behavior of the problems represented by the model, the solutions have been discussed in detail.

Keywords: Stiff Ordinary Differential Equation, Monte Carlo Method, Stochastic Method

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A New Approach to Exam-Session Planning in Multiple Session Exams

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Abstract

Educational scheduling problems are challenging and interesting optimization problems which are frequently encountered in academic studies. These problems consist of hard and soft constraints. Hard constraints have to be satisfied under any circumstances. The hard constraints of these problems are assigning all the necessary courses/examinations to the students, not exceeding the room capacities and appointing invigilators to the used rooms. Soft constraints need to be satisfied as much as possible. The soft constraints of these problems can be changed from one institution to other. For example, not to assigning student to consecutive exams can be soft constraint for some institutions [1].

Anadolu University's open and distance education faculty was opened in 1982, as the first school in open and distance education to serve Turkey [2]. In Anadolu University's open and distance education examinations, exam-session planning which there are more than one session and courses to be scheduled, namely booklet optimization, can be considered as a subset of the educational scheduling problems.

In this special case, the current input consists of the students and their programs-courses. Our goal is to create a new exam-session planning by assigning courses and booklets for sessions, by minimizing the required number of booklets per examination session and by reconsidering hard and soft constraints. For example a student can only have a limited number of courses and only one booklet per each session, all of the courses and booklets can only appear in only one of the sessions of the examination, etc.

Since the number of students in Anadolu University open and distance education system is more than 1.5 million and the total number of courses are 715, the slightest improvement in the system is returned to us with great achievements. It is also predicted that a new exam-session planning will yield good economic results if fewer books are printed during the examinations.

In this study, a mathematical model is established by determining all constraints, decision variables and multiple objectives for a pilot exam of North America Program which a new program of Anadolu University open education faculty. The exact solution has been investigated for this model by an optimization software which is GAMS. In the later phases of the study, it is also planned to develop a heuristic algorithm by resorting to intuitive and / or meta-intuitive methods.

Keywords: Booklet Optimization, Exam scheduling, Timetable scheduling, Optimization.

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Mathematical Modelling of a Medical Problem Using Multiple Linear Regression

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Abstract

The aim of this talk is to investigate if there is a relation between the inputs (eight blood variables, sex and age) and output (the disease) [1,2]. To achieve this, we have used linear regression model. The obtained results in terms of the proposed model seem to be reasonably good. For further studies, more analysis will be carried out for to improve the accuracy of the model [3-7].

Keywords: Anemia, Mathematical Modelling, Linear Regression Model.

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Interval Estimation of Beta-Glucan Content of Yeast by Using Fuzzy Least Squares Modeling Approach

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Abstract

Beta-glucans are described as polysaccharides and are composed of D-glucopyranosyl units. They have important impact on immune systems of the organisms. And also, the beta-glucans are widespread in many varieties of microorganisms and plants. One of the commonly used source of beta glucans is yeast since the yeast wall consists of about the 50-55 % beta-glucans and these are produced economically [1]. Beta-glucan content is important for economic production process and it is affected from both growth conditions of the yeast and extraction procedure [2]. In this study, it is aimed to define the optimal values of growth conditions, which are concentration of additive materials (EDTA, Sorbitol, $CaCl_2$), for increasing the content of beta-glucan in the yeast. The optimal condition values of temperature and pH are previously defined in the study of [3]. Experiments are done at specific levels of each additive materials and replicated measures of beta-glucan contents are obtained. In order to define the functional relationship between the beta-glucan content and concentration of additive materials, fuzzy least squares (FLS) modeling approach is applied [4, 5]. Because, it is seen that the statistical modeling assumptions are not satisfied on the experimental data. After evaluation of fuzzy predicted model, interval estimation of beta-glucan content of the yeast is obtained.

Keywords: Beta-glucan, fuzzy least squares (FLS) modeling, interval estimation

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A Nonlinear Modeling and Optimization Process: Obtaining Optimal Drying Conditions for Olive Leaves

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Abstract

Drying by using various type of equipment is commonly used process in food, chemical and pharmaceutic industries. Efficiency of drying process depends on type of equipment, drying conditions and wet material type. Olive leaves have a great attention due to their high phenolic content, which is shown an antioxidant activity, in recent years [1]. Before extraction process of phenolic compounds from olive leaves they must be dried in order to increase the extraction yield [2]. For this purpose, suitable drying equipment and drying conditions should be selected and applied for both economic and efficient drying. In this study, it is aimed to obtain optimal drying conditions, which are hot air input temperature (T, ^{o}C) and air flow rate (q, m/s), for dehumidification yield of olive leaves (x, %). Experiments were conducted at the same relative humidity of air. In modeling stage, nonlinear regression analysis [3] is used since the functional relationship between the drying conditions and yield of olive leaves is not linear. The optimization stage is achieved by using derivative-free optimization algorithms which are useful tools in nonlinear optimization [4]. And also, total phenolic content and olureopein level were analysed. It is seen that the drying the olive leaves under low air flow rate and low hot air input temperature resulted with less alteration of phenolic content and olureopein level.

Keywords: Drying, nonlinear regression, derivative-free optimization algorithms, olive leaves

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Solving the Single-level Capacitated Lot-sizing and Scheduling Problem with Setup Time Consideration

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Abstract

Capacitated lot-sizing is one of the most common production planning problems encountered in production companies. This paper studies a challenging case of joint lot sizing and scheduling problem in a paper bag production company. A mixed integer programming (MIP) model is developed by extending the model [1] and tested on multiple sets of real data. Setup cost/time between product and period changes are taken into account in the proposed model. Since neglecting the setup time can lead to infeasible plans or sub-optimal plans with high inventory. However, finding a feasible solution for larger instances turned out to be quite difficult with a standard MIP solver. Therefore, in this study we focus on providing feasible solutions within an appropriate time limit by using subcontracting in combination with the idea of the lexicographical approach from multi-objective optimization. In this approach, only one of the objectives is minimized at a time while the others are constrained by upper bounds [2]. Test results demonstrate that the formulations are computationally effective and with low modeling and programming effort a considerable improvement compared to the classical approach could be achieved. The schedule obtained from the solution of the proposed model substantially improves on that practiced at the company and can be useful for similar companies in the paper bag industry.

Keywords: Integrated lot sizing and scheduling problem, sequence-dependent setup cost, lexicographic method

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Order Selection and Scheduling Decisions in Make-to-order Manufacturing Environments

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Abstract

In this study, we examine simultaneous order selection and scheduling decisions in make-to-order (MTO) manufacturing environments. In the traditional production scheduling models, it is often assumed that all jobs/orders must be processed through the production systems without rejection. However, in MTO environment, order acceptance and scheduling are often simultaneously considered [1]. In this environment, some orders should be rejected if they cannot be managed effectively and delivered timely due to the limited capacities or resources. On the other hand, accepted orders should be scheduled effectively for maximizing revenue. Because, customer dissatisfaction will increase in parallel with tardiness from their due date. In this study, orders are defined by their release dates, processing times, sequence dependent setup times, due dates and selling prices in a single machine environment. In this study, selling prices and due dates which are usually considered as a parameters in literature are considered as decision variables**.** We developed a multi-objective mathematical model to select a set of potential customer orders to maximize the revenue and minimize the due date. In order to solve the multi-objective mixed-integer linear programming model, ε-constraint method is used [2]. We generated test instances and computational tests in order to indicate that the proposed models are both computationally efficient and effective.

Keywords: Order acceptance, sequence dependent setup times, single machine scheduling

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A Novel Minimal Placement Model with Tensors in Electronic Board Design

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Abstract

In recent years, electronics have begun to enter our lives as wearable electronic products. Wearable electronic products should be designed as small as possible in terms of ease of use. In order to develop wearable electronic products, either the PCB (Printed Circuit Board) area should be minimized or System-in-Packet (SiP) must be used. In fact, this electronic component placement problem is similar to Chen's pallet packing problem. The problem is formulated as a mixed binary linear programming problem[1]. In addition, there are genetic algorithm approaches to use for this problem[2][3].

In this study, we propose an optimization approach to minimize printed circuit board area by reformulating electronic component placement problem by utilizing the advanced capabilities of tensors. Our goal in using tensor is to minimize both the area of the PCB and the needs of the modern electronic system (SiP design) as pointed out by Berger[4].

In our model we defined the electronic components as combination of squares. Then we defined the constraints set so that the integrity of electronic components consisting of squares do not losing and when the tensor layers combine, the electronic components do not overlap with each other. Thus, we check that all components are correctly placed on the PCB. Also we develop a novel technique to minimally utilize the row and columns in the tensor by a commitment approach. As a result, we observe that the developed optimization model using tensors is computationally easier to solve and more flexible to improve for other engineering problems than the classical 2D placement approaches in the literature. We also demonstrate that the proposed approach could be useful for multi-layer electronic circuit designs in the future.

Keywords: Weighted-sum approach, Printed circuit board, Tensors, Wearable electronic device, Multilayer electronic circuit design.

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Scheduling Optimization of Large Scale Price Maker Energy Storage Systems

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Abstract

Energy storage systems have received attention in last decade due to providing several benefits to the system [1]. The most important one is the energy arbitrage which allows the electricity to be decoupled from the generation. The energy arbitrage action enables the large scale ESS having an effect on the electricity price by changing the net power demand (price maker), while the small scale ESSs are considered as price takers in the literature [2-4]. This paper includes a price maker model and 24-hour period is studied for the optimal scheduling. First, the scheduling optimization is executed to maximize the operation cost reduction and the maximum provided power of energy storage systems (ESS) is calculated based on the electricity demand of Turkey in 2018. However, the scheduling is optimized for the maximum cost reduction, the revenue for the storage-owner is not profitable in this case. After that point, the provided power by ESSs is calculated by maximizing the revenue for the storage owner. The revenue maximization problem can be modeled as a convex optimization problem and solved by CPLEX optimization tool as shown in [5]. In calculations, the optimized revenue for the unconstrained case does not excess the cost reduction, which indicates the feasibility of revenue maximization approach. Then, the various energy and power constraints in the current market are included to model. The results show that the provided power of ESSs with the current available technology reduces the prices at high demand levels and increases the prices at low demand levels. This balancing behavior of ESSs provide an operation cost reduction and also a revenue for the storage owner. In general, this paper shows that return of investment for the storage-owner is covered in 20-30 years for different constrained cases of ESSs.

Keywords: Energy Storage Systems, Price Maker, Scheduling Optimization

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Vehicle Routing Problems with Simultaneous Pickup and Delivery: Review and Research Perspectives

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Abstract

The classic vehicle routing problem (VRP) aims to construct routes in order to serve a set of customers for a fleet of homogeneous vehicles. Each route starts and ends at the depot, and each customer is visited once by one vehicle, and several side constraints are satisfied. Many variants and extensions of the VRP have been intensively studied in the last 60 years [3, 7]. One of them is VRP simultaneous pickup and delivery (VRPSPD) where goods have to be transported from different origins to different destinations. Each customer has both a delivery and a pickup demand to be satisfied simultaneously. The VRPSPD is also known as the multiple vehicle Hamiltonian one-to-many-to-one pickup and delivery problem with combined demands. The VRPSPD introduced by Min [4] inspired by the problem of pickup and delivery of books in a library. Berbeglia et al. [2] and Parragh et al. [5, 6] reviewed the pickup and delivery problems until 2007 and 2008. The book chapter of Battarra et al. [1] briefly reviewed several papers on the VRPSPD until 2014 without providing comparisons of computational performance. This study aims to comprehensively review the existing work on the VRPSPD, and its variants and extensions with an emphasis on the recent literature. It presents a detailed review on models, exact and heuristic algorithms, variants, industrial applications and case studies, and contains several synthetic tables. This study also compared state-of-the-art metaheuristics which play crucial roles to solve VRPSPD and its variants. The paper also proposes a number of promising research directions.

Keywords Vehicle routing; simultaneous pickup and delivery; survey; review

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Simulated Annealing for Vehicle Routing Problem with Alternative Links from the Triple Bottom Line Perspective

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Abstract

Recent years, global pollution effects can be seen every part of life, and attention about this increases. Fuel consumption is the part of global warming. Vehicle Routing Problem (VRP) has different kinds, and Green VRP (GVRP) interested in minimizing fual consumption and releasing harmful gases. Barth et. al. [1] composes fuel consumption equation. Erdoğan et. al. [2] also study about G-VRP and solution techniques. In this study, we consider vehicle routing problems on networks with alternative direct links between nodes, and we analyze financial, environmental and social objectives. We consider minimizing the cost of fuel, cost of drivers and cost of vehicles as the financial objective for the company, minimizing the CO2 emissions and gas usage as the environmental objective, and adjusting the drivers' working hours and balancing route times as the social objectives. Most of the vehicle routing problems assume a single link between nodes, but in real life, there might be more than one alternative direct link between nodes, and these links may have diffrences in terms of their lenghts and durations. We provide a multi objective mixed integer linear mathematical model with these considerations, and aim to determine the optimal routes and alternative links that should be used on each route, in addition to the speed choices on each link. VRP is NP-Hard problem and to solveproblem, we need heuristic methods. Franceschetti et. al. [3] used ALNS heuristic. Koç et. al. [4] Branch-Cut algorithm and SA used together. We develop a simulated annealing heuristic in order to solve this problem for small, medium and large sized instances. Eight neighborhood search procedures are used to increase the effectiveness of the heuristic method. We analyze the performance of our heuristic by comparing the solutions with the solutions obtained through commercial solvers.

Keywords: Vehicle Routing, Alternative Links Between Nodes, Simulated Annealing, Heuristic

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A New Auxiliary Function Approach for Inequality Constrained Global Optimization Problems

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Abstract

In this study, we deal with the nonlinear constrained global optimization problems. First, we introduce a new smooth exact penalty function for constrained optimization problems. We combine the exact penalty function with the auxiliary function in regard to constrained global optimization. We present a new auxiliary function approach and the adapted algorithm for solving nonlinear inequality constrained global optimization problems. Finally, we illustrate the efficiency of the algorithm on some numerical examples.

Keywords: Constrained optimization, penalty function, smoothing approach.

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Numerical Solutions of Gilson Pickering Equation by the Collocation Finite Element Method

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Abstract

This present study is going to provide a new numerical approach to Gilson pickering equation by combining collocation method, finite element method and quintic B-spline basis functions. During the process, first of all, the approximate solution of the problem expressed as a linear combination of B-spline basis functions and time dependent parameters. Then by using the main idea of collocation method which is approximating a solution to satisfy the equation at certain selected mesh points numerical scheme is constructed for the mentioned problem. With the help of a programming environment, numerical results have been obtained iteratively. To show the validity of the present method the error norms L_2 and L_∞ have been calculated and numerical simulations of approximate solutions have been presented. The results of this study indicate that finite element collocation method is an effective and coherent one for obtaining the numerical results of various partial differential equations.

Keywords: Finite element method, collocation, quintic B-spline basis, Gilson pickering equation.

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New Extension Sub-Equation Method for Fractional Order Boussinesq-like Equations

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Abstract

The present work proposes seeking new exact solutions for the variety of Boussinesq-like equations which play a vital role in many physical phenomena such as acoustic waves, vibrations in a nonlinear string, fluid mechanics The fractional transform is simple but effective way to convert fractional partial differential equations into integer order ordinary differential equations. Sub-equation method benefits using advantage of all kinds of solutions of chosen special nonlinear ordinary differential equation called as sub-equation. Sum up to, considered method allows to obtain trig, hyperbolic and rational solutions of the Boussinesq-like equations with the availability of symbolic computation. The method is practically well suited and useful tool for obtaining different kind of exact solutions of integer or fractional order partial differential equations.

Keywords: New Extension Sub-Equation Method, Conformable, exact solutions

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The Extended Modified Exp-$(-\Omega(\xi))$ Method and Its Application to Some Fractional Differential Equations

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Abstract

The aim of this work is to get new exact solutions of some fractional coupled differential equations by implementation of extended modified exp-$(-\Omega(\xi))$ method which is a new method proposed by Khater et al. For this purpose, we are going to consider Conformable fractional Driefld –Sokolov-Wilson equation and Conformable Boussinesq Burgers equation which are two coupled equations seen frequently in a number of scientific models such as fluid mechanics, optical fiber and geochemistry. During the process, the new exact solutions of the fractional equations are obtained by using the properties of conformable derivative and application of the mentioned method. Computer simulations of the newly obtained solutions are also presented. Our results show that extended modified exp-$(-\Omega(\xi))$ method is an effective and powerful tool for obtaining exact solutions and can also be applied to various types of fractional order differential equations.

Keywords: extended modified exp-$(-\Omega(\xi))$ method, Driefld –sokolov-Wilson equation, Boussinesq Burgers equation, Conformable derivative, Exact solution.

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Hypothesis Testing in One-way ANOVA based on Fiducial Approach when the Error Terms have Weibull Distribution and Heterogeneous Variances

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Abstract

In this study, we propose a new test statistic based on fiducial approach for testing the treatment effects in one-way analysis of variance (ANOVA), see Fisher [1] for the idea of fiducial inference. Unlike the usual ANOVA assumptions, we assume that distribution of the error terms is Weibull which is one of the well-known and widely used skew distribution in literature. We also assume that the variances of the error terms are heterogeneous in each treatment.

We use Tiku's modified maximum likelihood (MML) methodology to obtain the estimators of the model parameters, see Tiku [2]. Different than the maximum likelihood (ML) estimators, MML estimators have closed forms therefore we don't need any iterative method to solve the likelihood equations. They are also asymptotically equivalent to the ML estimators.

We compare our results with the results of Li et al. [3] which is based on normally distributed error terms via Monte Carlo simulation study. Simulation results show that proposed test is more powerful than the corresponding test based on the least squares (LS) estimators. An example is analyzed at the end of the study for illustrative purposes.

Keywords: Fiducial approach, Weibull distribution, modified likelihood, Monte Carlo simulation, Taylor series

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Smoothing Technique with Auxiliary Function Thru Bezier Curves for Global Optimization

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Abstract

In this paper, we deal with the minimization of non-smooth and non-Lipschitz functions. We first propose a new smoothing approach. Second, we reformulate given a problem as one-dimensional equation, then a new auxiliary function method has been designed to solve the reformulated global optimization problem. Finally, numerical experiments have been performed on test problems which have been taken from the literature for showing the overall performance of the new method.

Keywords: Global optimization, Bezier curves, Lipschitz objective function, auxiliary function.

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Optimal Storage Units' Sizing and Placements within the Turkish Power Transmission Grid

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Abstract

The energy demand in Turkey forms a peak during the day time due to the high industrial and commercial usage and decreases during the night when these activities are no longer operational. Energy storage is to store energy during the low demand period and enables its consumption within the peak demand period. It allows power generation optimization within multiple periods of time [1]. Moreover, it decreases the dependency on the conventional energy generation during peak load period [2].

This paper looks at the energy storage problem as a bi-level optimization problem; in which the first stage runs a Security Constraints Unit Commitment (SCUC) model including the hourly energy demand within 24 hours. The results include the maximum power and the maximum energy that can be deployed as an energy storage system for the Turkish power grid. The second stage of the problem, distributes the maximum power and the maximum energy to the buses in the grid by running the optimal power flow (OPF) problem with the physical constraints of the network included. Depending on the optimization algorithm used in this study, an energy policy is created to decide the optimal sizes and the optimal placement of the storage units required at each bus.

Keywords: Energy storage, unit commitment, optimal power flow, energy storage policy.

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Numerical Investigation of Heat Transfer in the Thermal Energy Storage Unit

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Abstract

Thermal energy storage (TES) has a great importance for energy efficiency gains in storing solar energy or waste heat in industrial processes. Thermal energy can be stored in two basic techniques; sensible energy and latent heat energy [1]. Due to its higher energy storage density at relatively constant transition temperature using phase change materials (PCMs), latent heat energy storage is more preferred in low and medium temperature applications. The fact that PCMs have a low thermal conductivity coefficient causes long term storage of heat from the heat transfer fluid (HTF) [2,3]. The usage of fins in the heat exchanger in the TES unit provides a quick storage of the thermal energy by significantly shortening the melting time of the PCM [4].

In this study, thermal behavior in energy storage unit using PCMs and the effect of the use of a fin in a heat exchanger on TES is numerically investigated. Two-dimensional numerical analysis was carried out using the ANSYS Fluent 16.2 commercial software using the computational fluid dynamics (CFD) approach which was developed based on the enthalpy-porosity method to simulate the unsteady melting process including temperature and liquid fraction variations. It was chosen Paraffin RT50 (melting point between 318 - 324 K) as PCM and water as HTF. The numerical analysis results indicated that PCM completely stored the heat the heat from the heat exchanger in 300 minutes. When 12 fins were used in the heat exchanger, PCM stored the heat in 60 minutes. The use of fin has positively influenced the heat transfer and the melting time in TES unit. Besides, the results can contribute to the future thermal energy storage design and practical applications.

Keywords: Thermal energy storage, phase change material, numerical analysis

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A New Design of Solar-Assisted Heat Pump with Energy Storage for Heating Greenhouses

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Abstract

Heat pumps are energy efficient devices that can be used for both heating and cooling, which can supply more heat energy from the work input they receive. In the direct solar-assisted heat pump systems, the energy requires for the evaporator is met by the sun [1,2]. When this system is supported by the energy storage unit, it operates continuous and stable by providing maximum energy efficiency and reliable energy source. Solar-assisted heat pump with the energy storage system is as an alternative for reducing energy use and costs for greenhouse heating, particularly if off-peak electricity is used [3].

In this study, a new generation energy storage solar-assisted heat pump is designed for the heating of greenhouses. When solar radiation is absent, it is aimed at providing energy from the storage unit for heating the greenhouses. For this new system, R410a is chosen refrigerant, which is a commercially available material. Paraffin is selected as energy storage materials, too. The main purpose of this work is to perform the energy (thermodynamics) analyze of the solar-assisted heat pump designed for the heating of greenhouses and to determine the performance coefficient (COP) of this new designed system. The thermal performance results predicted from this new system indicate that system COP ranging from 3 to 5.5 for winter time. We conclude that energy storage unit can improve a solar assisted heat pump systems energy efficiency and be for an effective method heating greenhouse. The evaluations resulting from this study may assist for the further studies and their associated technologies.

Keywords: Heat pump, solar energy, heating greenhouses, energy storage

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A New Auxiliary Function Method for Unconstrained Global Optimization

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Abstract

In this paper, a new auxiliary function method is proposed for solving unconstrained global optimization problems. First, a new definition of the auxiliary function is given under reasonable assumptions. The proposed auxiliary function is continuously differentiable and contains two parameters. Then a new algorithm is presented depending on the theoretical and numerical properties of the proposed auxiliary function. Finally, the execution of the algorithm on different test problems is stated with acceptable numerical results.

Keywords: Auxiliary function method, unconstrained global optimization, global minimizer

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Solving Discrete Time Infinite Horizon Optimal Control Problems by Weak Pontryagin's Principle: Method and Applications

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Abstract

In this paper, we aim to apply the approach of weak Pontryagin's principle to different types of discrete time infinite horizon optimal control problems. The idea of this approach is to transform the optimal control problem to a dynamical system which is governed by a difference inequation. This result, presented first in [1] then studied in [2] and [3], establishes weak Pontryagin's principles as necessary and sufficient conditions of optimality.

This paper provides some examples of optimal control problems such as optimal growth problems, optimal accumulation problems and some dynamic game theoretical problems encountered in economics and operational research. In particular, we consider some variations of the infinite horizon discrete time optimal growth problem given in [4] defined by scalar state and control variables. For each example we demonstrate the advantage of the approach of weak Pontryagin's principle.

Keywords: Optimal control, weak Pontryagin's principle, difference inequation.

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Comparison of Classification Algorithms used in Intrusion Detection Systems

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Abstract

Intrusion Detection Systems (IDS) are used for the protection of sensitive information and networks in many different areas. Analyzing the knowledge that traffic generated in large networks is intruded by accessing requires complex operations. In addition, accuracy and performance in detecting intrusion is crucial to effectively and efficiently determine the actual attack. The most effective way to quickly accomplish such complex operations is to identify them via classification and learning algorithms and previously processed attack information.

KDD dataset, which is commonly used in studies on IDS, has been in use for many years. NSL-KDD dataset is presented as a revised version since some problems found in the KDD dataset. This dataset contains 41 parameters and a class tag. The class tag has a value of "normal" or "anomaly". It also contains classified data according to the attack type. These types of attacks are classified in 4 basic headings: Denial of Service Attack (DoS), Probing Attack (Probe), Remote to Local Attack (R2L) and User to Root Attack (U2R). Naïve Bayes [1-3], C4.5 [3], Random Forest [3] and Artificial Neural Networks [1] are used in the classification studies made with NSL-KDD dataset in general. The accuracy rates of the algorithms on the dataset are different. Therefore, feature selection algorithms are used to select the important parameters to give better results [2].

In this study, Repeated Incremental Pruning to Produce Error Reduction (RIPPER), Back Propagation Artificial Neural Networks (BP-ANN), Random Forest (RF), C4.5, Support Vector Machine (SVM), K-Nearest Neighbors (k-NN) algorithms are compared on the NSL-KDD data set. According to the obtained results, all algorithms except C4.5 and SVM showed high performance. Feature selection methods are used to increase the performance of C4.5 and SVM. Following the use of attribute selection methods, an increase in the accuracy rate of the classification has been observed according to the number of parameters and the change in the parameter type.

Keywords: Intrusion detection system, classification, feature selection

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Estimating the Parameters of Truncated Jones and Faddy's Skew *t* Distribution

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Abstract

Truncated data which do not include the observations beyond a boundary value are encountered in different fields of science including reliability, astronomy, environmental study, and so on. There are various studies about truncated distributions such as skewed multivariate distributions [1], skew-normal distribution [2, 3], skew-t distribution [4], etc.

In this study, we obtain the estimators of the parameters of truncated Jones and Faddy's skew *t* (JFST) distribution [5] via the modified maximum likelihood (MML) methodology proposed by Tiku[6]. JFST distribution is very flexible for modeling the data sets having the symmetric or skew distributions. It reduces to the well-known Student's t distribution when the shape parameters *a* and *b* are equal. The MML methodology is based on the idea of linearization of the likelihood equations using the first two terms of the Taylor series expansion. The MML estimators are asymptotically equivalent to the maximum likelihood (ML) estimators. Therefore, they are almost fully efficient in terms of minimum variance bounds [7].

Keywords: Modified likelihood, Truncation, Taylor series expansion, JFST distribution.

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Secure Multiparty Computation and Blockchain-Smart Contract Based Election System

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Abstract

Blockchain-based smart contracts are programmable contracts and secure protocols that are trackable and irreversible without intermediaries, based on cryptography that use blockchain infrastructure. Every programmable process, flow or contract can be made into a smart contract that automatically takes place without any intervention when the conditions are met [1]. Smart contracts using the blockchain infrastructure are validated once the conditions have been met, after reaching the number of sufficient validation counts that are hash functions cryptographically computed by the nodes in the network [2]. Secure Multiparty Computation (MPC) is a subfield of cryptography that allows multiple participants to contribute to the final result by computing with its own secret key (signature) and data and with an open function [3]. In an MPC, a given number of participants, p_1, p_2, ..., p_n, each have secret key and private data, respectively d_1, d_2, ..., d_n; MPC compute the value of a public function on that private data: $f(d_1, d_2, ..., d_n)$ while keeping participants and their inputs secret [2]. One of the first applications of MPC is fairplay systems which use Yao-based protocols, consisting of XOR and AND gates, followed by Advanced Encryption Standard (AES) circuit based active safety MPC systems developed by Lindell and Pikas [3]. Parallel computing has been accelerated with GPU systems [4], and GPUs have begun to be used to calculate the hash for secure MPC and blockchain infrastructure.

In this study, a secure MPC and blockchain smart contract based election system is proposed. With the MPC, the data representing the voter's secret key (electronic signature) and the name of the voting candidate can be determined by placing a smart contract in a block on the network and counting the votes received by each candidate in the function in the MPC circuit after receiving sufficient number of approvals in blockchain. Thus, while the cost of selection is greatly reduced, election security and privacy will be ensured at the highest level. Since all transactions are cryptographically performed, a system can be established in which a fake voting, such as the use of repeated voting, is not possible since it can be follow up by anyone.

Keywords: secure multiparty computation, smart contract, election system, blockchain

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Commercial Advertisements Scheduling Problem

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Abstract

An important source of revenues for Channel 4, British TV Cooperation, comes from the campaign advertisement during commercial breaks. Campaigns are agreed between Channel 4 and its customers on the basis of CPT (Cost per thousand. This is the amount of money that a Channel 4's customers have to pay for 1000 impacts), customer's budget and targeted audience. The deal is then translated into some amount of TVR (TV attraction to measure the audience for a program or a commercial break) that Channel 4 must achieve for this campaign. This is operationally done by allocating spots of this campaign during commercial breaks. The main problem is then to determine for every campaign which breaks it should have spots in.

Based on pricing and value of each break of a program, the aim of Channel 4 is to have an automated system for doing allocation of spots to commercial breaks in the best way possible to maximize the value of audience attractions and limited customer budgets.

This campaign allocation problem (CAP) can be formulated as a mixed integer programming problem (MIP) which is NP-Completed hard. Due to the size of problem, which could have 3m integer variables and about the same number of constraints, we develop both MIP optimal and heuristic procedures to solve the problem. A number of tests on real datasets have been made. Comparing the solutions from CAMGEN, the current computer system in Channel 4, we conclude that ILOG CPLEX solution procedures can bring more than £10m revenue increasing per month to Channel 4 while respect all business constraints.

Keywords: Scheduling, TV Campaign Advertisement, Large-scale Integer Programming

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The Future Promise of Vehicle-to-Grid (V2G) Optimization - Optimal Scheduling Methods to Integrate Plug-in Electric Vehicles

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Abstract

With the growing concern on global climate change, governments and industries have invested in environmentally friendly technologies, mostly encouraging the adoption of electric vehicles (EVs) since the transportation sector is responsible for 24% of greenhouse gas emission. [1] The next-generation EVs have drawn the interest of researchers in recent years, with the interaction between EVs and the power grid has spurred the emergence of a smart grid technology, denoted as vehicle-to grid-technology (V2G). [2]

V2G technology allows EV's battery to charge from and discharge to the grid by smart grid technologies to provide demand response services. The difference of V2G from a standard charging point is that energy flows both to and from the vehicle, turning it into a portable battery store. V2G can improve the power system's resiliency and reliability. All popular electrical vehicle models can completely compensate the energy cost and generate a positive net profit through the application of a scheduling optimization model. [3]

Based on the software called On-Base EV Infrastructure [4] , a simulation model can be created, regulating the microgrid when daily events occur during a full day. [5] V2G system in the simulation model is controlling the charge of the batteries connected to it and uses the available power in the batteries to regulate the grid. By observing the data from cars and energy resources; various optimization techniques can be utilized efficiently to accomplish different V2G objectives while satisfying a set of constraints.

Theoretical analysis and simulation results with almost real-time data on the vehicles and their battery status indicate that through the scheme of dynamic pricing and charging scheduling for EVs, the charge stations can maximize their profit while EVs maximize their utilities, simultaneously optimizing the system total running cost and reducing greenhouse gas emissions.

Keywords: Electric vehicles, smart grid technology, Vehicle-to-grid

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A New Outlook: A Numerical Study on Rosenau-Burgers Equation via Galerkin Finite Element Method

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Abstract

The focus of this article is on obtaining numerical solutions of Rosenau -Burger's equation ,an important and well-known problem in mathematical physics, using Galerkin Finite element method. The method is based on firstly constructing weak form of the problem and setting up an approximate solution of the problem as a linear combination of time dependent shape parameters and basis functions. For the considered problem, the approximate solution has been formed using cubic B-spline basis functions. Then, with the help of finite element procedure, nonlinear partial differential equation (NPDE) is converted into a system of ordinary differential equation (ODE). Due to its high accuracy, applicability and memory requirement, fourth order Runge-Kutta method has been used to solve the system and thus numerical solutions have been obtained. The incorporation of the Galerkin method into Finite element formulization ~~is~~ allows better convergent results. As a result of article, these newly obtained results are presented in tables as well as graphics.

Keywords: Rosenau-Burgers equation, Galerkin, Finite Element Method, B-spline

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Numerical Study on Blood Flow Modelling in Arteries

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Abstract

In order to prevent, diagnose and treat vascular disease, detailed knowledge of blood blow and the response of blood vessels is essential. The use of computer simulations can provide researchers extremely useful tool of the interpretation and analysis of the circulatory sysytem in both physiological and pathological situations. In this work, we present a 2D mathematical model to forecast for some cardivascular diseases such as stenosis and aneurysms geometry. We consider a blood flow based on Stokes and Navier Stokes equations (NSE). The finite element numerical solutions are obtained based on grad div stabilization. Numerical experiments will be presented in different geometries to verify almost all common practical knowledge.

Keywords: blood flowing, grad-div stabilization, finite element

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Swarm Intelligence Enchanged by Oblique Section Planes for Solving Dirichlet Boundary Problems for ODEs

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Abstract

Description of the systems are substantial step for the solution of daily life problems, and the modelling of the complex systems is mostly come true by the means of stating differential equations. To obtain the numerical solutions of differential equations using traditional methods, firstly, the continuous domain is discretized by welcoming some cumulative errors. Furthermore, the numerical solutions are available only at discretization nodes.

Artificial Neural Networks (ANNs) have been introduced as an alternative approach to overcome these bottlenecks in last two decades [1-5]. ANNs are superior to classical numerical methods by means of training with the discretization nodes and providing the approximate solutions at any point of continous search space. ANNs are mostly trained by derivative based optimization methods such as Gradient Descent, Scaled Conjugate Gradient and Levenberg-Marquardt optimizers.

In this work, we put into practice derivative-free population based global optimization methods such as Artificial Bee Colony (ABC), Ant Colony Optimization (ACO), Gravitational Search Algorithm (GSA), Particle Swarm Optimization (PSO) and the hybridization some of them to train a Feed-forward Neural Network for solving Dirichlet Boundary Problems of Ordinary Differential Equations. Furthermore, we hybridize ACO, ABC and GSA with PSO by generating mutations of global best solutions on an oblique section plane in *n* dimensional surface characterized by fitness function.

In the experiments, we give some different DBPs in order to indicate the efficiency of methods. Also the results are compared with the well known traditional method as Shooting Method, Finite Difference Method and Lobatto IIIa. Finally, some considerations about future directions are given.

Keywords: Differential Equations, Neural Networks, Swarm Intelligence, ABC, ACO, PSO, GSA

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A Simplified Neutrosophic Multiplicative Set-Based Method for Multicriteria Decision Making

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Abstract

Simplified neutrosophic set (SNS) is a useful tool to describe the vagueness and uncertainty existing in the real decision-making. A SNS consists of a combination of neutrosophic numbers that are defined as simplified neutrosophic numbers (SNNs). A SNN has three membership degrees which is characterized independently by the truth, indeterminacy and falsity. In this study, we define the concept of simplified neutrosophic multiplicative set (SNMS) and introduce simplified neutrosophic multiplicative number (SNMN) as a component of SNMS. We present the score function, accuracy function, properties and operational rules of the SNMNs. Furthermore, we develop two simplified neutrosophic multiplicative aggregation operators that are called as simplified neutrosophic multiplicative weighted arithmetic average (SNMWA) operator and simplified neutrosophic multiplicative weighted geometric average (SNMWG) operator on SNMNs. In the meantime, we study some important properties of these operators, and develop a method based on SNMWA operator for multicriteria decision making. Finally, we use an example to demonstrate the effectiveness of the proposed method.

Keywords: Simplified neutrosophic set, multiplicative preference relations, aggregation operator

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Simplified Neutrosophic Multiplicative Similarity Measures and Their Application to Pattern Recognition Problems

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Abstract

The simplified neutrosophic multiplicative set (SNMS), whose elements are simplified neutrosophic multiplicative numbers (SNMNs) is a generalization of intuitionistic multiplicative set (IMS) which can be used in real scientific and engineering applications. SNMNs are basic components of SNMS that are characterized by truth membership degree, indeterminacy membership degree and falsity membership degree, respectively. In this study, firstly, the simplified neutrosophic multiplicative set (SNMS) and simplified neutrosophic multiplicative number (SNMN) are introduced, in which the truth-membership degree, indeterminacy-membership degree and falsity-membership degree are crisp values with respect to Saaty's 1-9 scale instead of symmetrical scale in a simplified neutrosophic numbers. Subsequently, some operator laws of SNMNs such as score and accuracy functions are discussed. Then a similarity measure formulation is proposed to measure the relationship between two SNMNs, and also some properties of the proposed similarity measure are proved. Finally, a pattern recognition problem is solved to indicate the potency and effectives of the presented similarity measure.

Keywords: Simplified neutrosophic set, similarity measure, pattern recognition problem

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An Approach to Multicriteria Decision Making Based on Distance Measures for Probabilistic Simplified Neutrosophic Information

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Abstract

Probabilistic simplified Neutrosophic set is an important tool to modelling economic, industrial, commercial, scientific, engineering, etc. problems in real world. Probabilistic Neutrosophic number has three component which is called truth membership degree, indeterminacy membership degree and falsity membership degree respectively and their probabilities. Due to the take into consideration components and their probabilities at the same time, it is more effective and reliable to describe problems emerges in many fields. For this purpose, Probabilistic simplified Neutrosophic set (PSNS) and Probabilistic simplified Neutrosophic number (PSNN) are introduced. Then distances are defined to determine the relation between PSNSs.

As an application of the developed distance measures, a method to solve a multicriteria decision making problem is developed in which the evaluation data given by decision makers have probabilistic simplified Neutrosophic value.

Finally, a numerical example is applied to demonstrate the effectiveness and validity of the developed method.

Keywords: Simplified neutrosphic set, Distance measure, Hamming distance

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Multicriteria Decision Making Based on Probabilistic Simplified Neutrosophic Numbers

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Abstract

Probabilistic simplified neutrosophic set is an important tool to describe the vagueness existing in the real decision making. In this study we first define a probabilistic simplified neutrosophic set (PSNS) and its basic component called as the probabilistic simplified neutrosophic number (PSNN). Then we discuss some operational rules of on PSNNs. In a PSNN, there are three membership degrees, such as truth-membership, indeterminacy-membership and falsity-membership, respectively with their probabilities. Furthermore, we give the algebraic operational rules and score function, accuracy function of the PSNNs, and also introduce two aggregation operators called probabilistic simplified neutrosophic weighted arithmetic average (PSNWA) operator and probabilistic simplified neutrosophic weighted geometric average operator (PSNWG) on PSNNs. Then we prove some properties of PSNWA and PSNWG. As an application of this theory, we establish a multi criteria decision making method based on the PSNWA operator, and present a numerical example to ensure stability of the developed method.

Keywords: Simplified neutrosophic set, Group decision making matrix, Aggregation operator

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Multi-Objective Optimization of a Parallel Machine Scheduling Problem Using Epsilon Constraint Method

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Abstract

Having more than one machine that does the same job provides capacity increase and flexibility to businesses. On the other hand, managing the capacity at hand is a serious problem. Multiple machines capable of doing the same job are called as parallel machines. Scheduling of such machines is much more complicated than single machine scheduling. While the research studies in the parallel machine scheduling literature have investigated different objectives from various aspects, in this study the minimization of job tardiness and machine deteriorating costs are two objectives. First objective is job tardiness which is a very common objective and is equal to its completion time minus its due date, in case the job is completely processed only after its due date, and is equal to zero otherwise [1]. Second objective is the deterioration of jobs in which the processing time of a job is an increasing function of its position in the sequence has been first introduced by Browne and Yechiali [2]. Jobs also may deteriorate, while waiting to be processed. By the effect of job deterioration, job processing times are defined by a function of their starting times and positions in the sequence In this study, a bi-objective parallel machine scheduling problem that has been formulated in the literature has been taken into account in a multi-objective manner [3]. The model has been coded with GAMS 24.6.1 software and pareto optimal curve of the multi-objective optimization problem has been generated with the Epsilon constraint method. The results obtained were compared with the results of classical weighted sum scalarization method.

Keywords: Scheduling, multi-objective optimization, epsilon constraint method

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Wastewater Treatment Plant Modeling and Simulation with Control Purposes

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Abstract

According to a survey on Municipal Wastewater Statistics in Turkey, there are 1338 municipalities out of a total of 1396 with a sewerage network. The implemented sewerage network collects 4.5 billion cubic meters of wastewater, 3.8 billion of which is treated at wastewater treatment (WWT) plants [1]. Treatment of urban wastewater has been a topic of primary interest in recent decades. In order to perform efficient operations on this steadily growing field, wastewater management and investments should be well-organized. The WWT process can be summarized in four main stages: Physical treatment, Chemical treatment, Biological treatment, and Advanced Biological Treatment. All the usages and purposes of these stages are examined in literature in detail [2, 3]. Early efforts of modeling and simulation of water and wastewater processes were discussed in 1973 in the Instrumentation and Control Automation (ICA) conference, sponsored by International Association of Water Pollution Research (IAWPR). In following years, this environmental organization was named as IWA (International Water Association) [4]. Over the last 40 years, the development of control systems and related structures escaladed rapidly. In the last two decades studies are focused more on computer simulations. Research at McMaster University, Hamilton, Ontario, Canada led to the commercial package GPS-X from Hydromantis with Gilles Patry and Imre Takács as the key actors. Several other applications specific simulator packages have appeared, such as Aquasim, BioWin, Simba, STOAT and WEST [4-5]. In current research, a simplified grey-box approach to mathematical modeling of WWT plants with control purposes is proposed. Proposed method yields a model that is simple enough for simulation and control design in personal computers using common mathematics software packages that are nonspecific to WWT. Differential equation model for each fundamental component of a typical WWT plant is presented and simplified whenever appropriate. Resulting model constitutes a simple input-output structure suitable for feedback control implementations at various stages to overcome disturbances. Obtained mathematical model is tested via computer simulations using actual WWT plant data provided by Gaziantep Metropolitan Municipality.

Keywords: Wastewater treatment, mathematical modeling, computer simulation, grey-box model

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On Fractional Calculus and Inequalities

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Abstract

The beginning of fractional derivative is as old as ordinary derivation and integration. In 1695, L'Hospital asked "what would be the one-half derivative of x?" to Leibniz. From that time, many authors tried to give a definition of fractional derivative to establish a coherent Theory of fractional derivatives and integrals. Throughout the 20th century, some definitions of fractional derivative, are introduced, most notably Riemann-Liouville, Caputo, and Grünwald-Letnikov derivatives. Since fractional derivation and integration have applications in different branches of sciences like engineering, physics, chemistry, etc., many mathematicians begin to study of aspects of it. For more information about the history and applications, we refer [1,2].

The definitions we mentioned above used the integral form. As an example, the idea Riemann-Liouville fractional integral is based on iterating n times and replacing it by one integral, and then using the Cauchy formula with replacing n! with Gamma function. Hence, Riemann-Liouville fractional integral is defined as

$$J_a^\alpha f(x) = \frac{1}{\Gamma(\alpha)} \int_a^x (x-t)^{\alpha-1} f(t) dt.$$

Using this definition, fractional derivative is defined as

$$D_a^\alpha f(x) = D^m J_a^{m-\alpha} f(x),$$

where $m = \lceil \alpha \rceil$ and D represents ordinary derivative.

Riemann-Liouville or any of other definitions for fractional derivative does not satisfies all properties of ordinary derivative. As an example, Riemann-Liouville derivation does not satisfy well-known formula of the product of two functions. Because of these difficulties, recently some authors tried to give new definitions for fractional derivatives. To handle these difficulties, in 2014 Khalil et al. [3] gave a new definition. This definition, named conformable fractional derivative, satisfies many properties of ordinary derivations like product rule, chain rule etc., see [3,4].

In this presentation, using this new definition, we give some integral inequalities of Jensen's type [5].

Keywords: Fractional derivative and integral, Integral inequalities

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Risk Analysis with Bow-Tie Analysis in Shipbuilding Industry

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Abstract

Risk analysis is a systematic and widespread methodology to investigate and evaluate risks which come across in many working areas. Quantitative Risk Assessment (QRA) is one of the most common tools of risk analysis. QRA is known as a tool to define the theory and the implementation of the risk management process to prevent accidents. Bow- Tie analysis is a method of QRA and it indicates the relationship between the hazards, potential adverse consequences and the factors that could cause harms. It performs with selecting and ranking potential risks including causes and consequences also expose a clear distinction between proactive and reactive risk management. Bow-tie analysis has been applied in many different work areas, such as, defense and security, shipping (taking into consideration ports and harbors), petrochemical companies mining, medical, aviation, oil and gas industries and emergency response. Shipbuilding industry which includes the shipyards, the marine equipment producers, and many related service and knowledge providers) raised as an important and strategic industry in a number of countries around the world. It has many risky processes and work units because of the essence of the work. This study suggests an occupational risk-assessment approach, which is known as Bow-tie analysis, in shipbuilding processes and work units. The aim is to evaluate critical risk operations and risky shipyard work units and to provide taking proper precautions against accidents which arise from risky conditions.

Keywords: QRA, Risk Analysis, Shipbuilding, Bow-Tie analysis.

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Sensitivity Analysis Indicator for Project Evaluation under Uncertainty and Risk

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Abstract

Project investment refers to the processes, which help managers to take reasonable decisions, to make profitable investments never takes place under conditions of certainty, but only under those of uncertainty or risk. It also includes a procedure to identify, assess and select the most applicable long-term project in compliance with budget constraints. The best prominent methods engaged in investment decision making are: Break-even Analysis, Sensitivity Analysis, Scenario Analysis, Theory of Games and Decision Making Theory. Using the discounted cash flows, net present value (NPV) and internal rate of return (IRR) are among the best known methods which are performed in the evaluation of investment projects. When NPV > 0, the investment project is measured effective and, vice versa, when NPV < 0, the project is considered ineffective from the economic point of view and is rejected. Sensitivity analysis is among analytical method to evaluate risky projects using an assessment of NPV for each of the situations that the project's proposed parameters obtain the values of optimistic, pessimistic, or most likely. A sensitivity analysis is one of the methods which is used to indicate how different values of an independent variable impact a specific dependent variable under a certain set of assumptions. The application of sensitivity analysis in investment project evaluation is performed under uncertainty and risk. In this study, it is suggested sensitivity analysis to review the influence of parameters, to prioritize the significance of parameters based on their influence, and (3) quantify uncertainty of the model.

Keywords: Investment projects, Risk, Sensitivity Analysis.

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Mathematical Modelling Approach to Increase Cell Efficiency in a Furniture Firm

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Abstract

Traditional production methods are insufficient to meet today's increasing demands. In order to adapt of changing customer requirements, product diversity has increased the need for more economical tools and methods in production systems. To this end, many businesses are interested in modern approaches. Cellular production, one of the modern approaches, makes it possible to increase production speed and produce at lower cost. Cellular production works on the principle of bringing together the parts to be processed in production and the machines that will process the parts. In this study, groups of machines, parts families, and cell formation problems were investigated for the transition to a cellular manufacturing and group technology of a furniture factory which has a line flow production system to prevent losses due to transportation and to increase productivity rate. For cell formation and design, 0-1 integer mathematical programming model is prepared. It is solved by using GAMS software. Proposed model can group parts and machines simultaneously. A new cellular system has been proposed for the business to get rid of losses due to transportation and stacking of parts.

Keywords: Cellular Manufacturing, Cell Formation, Mathematical Modelling

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Application of a Cellular Manufacturing in a Company and a New Layout Suggestion

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Abstract

Businesses have begun to seek solutions to bring flexibility and efficiency to their production systems in order to adapt to today's environments. In such an environment, businesses prefer modern production systems that are effective in achieving productivity and competition targets. In this study, problems of a business are tried to be handled with the philosophy of modern production systems. These problems due to uncertainties in demand quantities, variability of parts, different process times, and the different number of processes can cause a complexity in the production flow. For this reason, there are difficulties in production planning and control as a result with late delivery. Such problems can be handled with cellular production. Cellular manufacturing tries to cluster component families according to their design, manufacturing, and function, and machine groups that process these components in the form of machine groups. Thus, large and complex manufacturing systems are separated into small and easy-to-control subsystems. In this study, the problems of a company that produces in a modular fashion have been investigated. Cellular manufacturing approach has been used to solve the problems in the company. Machine-part groups are created using ROC (Rank Order Clustering) Algorithm. A new layout suggestion has been proposed for the company. The current and proposed layout is compared.

Keywords: Cellular Production, ROC (Rank Order Clustering) Algorithm, Layout

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A Hybrid Artificial Bee Colony Algorithm for Capacitated Vehicle Routing Problem – A Case Study

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Abstract

In this study, a real-life vehicle routing problem is taken into account. The required data was obtained from a retail product distribution company operating in Trabzon. The problem addressed is a two-vehicle problem involving both time constraints and capacity constraints. This problem resembles the characteristics of its basic features that it has described in the study of [1].

An integer linear mathematical model has been established to solve the problem. The generated model has been successful in obtaining the optimum solution for small dimensional problems. For large-scale problems that the mathematical model can't solve, a hybrid Artificial Bee Colony Algorithm has been developed. The proposed model is an advanced form of the algorithm in [2]. The effectiveness of the heuristic model is demonstrated by comparing it with the mathematical model results obtained in small-sized problems. As a result of the study, an effective solution for the large-scale vehicle routing problem covering all the suppliers of the firm was established.

Keywords: Supply chain, capacitated vehicle routing, hybrid meta-heuristics

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An Efficient Numerical Technique for the Rosenau-KdV-RLW Equation

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Abstract

In the present study, Rosenau-Korteweg de Vries- Regularized Long Wave (Rosenau-KdV-RLW) equation is transformed into a partial differential equation system consisting of two equations using a splitting technique. Then, numerical solution for the Rosenau-KdV-RLW equation system is proposed using B-Spline finite element collocation method. The unknowns in those equations are going to be found out using B-spline base functions in space and Crank-Nicolson type finite difference schemes in time for advancing solutions. Test problems are chosen to check the accuracy of the proposed numerical scheme. The fundamental conservative properties of Rosenau-KdV-RLW equation are seen to be preserved by the proposed numerical scheme. The obtained results are compared with analytical solution of the problem and some solutions in the literature. The errors norms L_2 and L_∞ are calculated for reliability of method. It is seen that the proposed method yields the results compatible with the exact solutions

Keywords: Rosenau-KdV-RLW equation, B-Spline functions, collocation method, splitting technique

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Comparison of Tests for the Homogeneity of Inverse Gaussian Scale Parameters

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Abstract

In recent years, the Inverse Gaussian (IG) distribution has been widely used in describing and analyzing right skewed data in many fields [1, 2].

The main appeal of IG distribution lies in these facts: a) it can accommodate a variety of shapes, from highly skewed to almost normal; b) it is unique among the distributions for positively right-skewed data such as Weibull, gamma and log normal due to the fact that it shares many elegant and convenient properties with Gaussian models [3].

The aim of this study is to compare the most commonly used tests for the homogeneity of IG scale parameters. A simulation study and a real word application are performed to evaluate power and Type I error rates of these tests.

Keywords: Inverse Gaussian distribution, scale parameters, Monte Carlo simulation

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A Discussion of the Singular and Weakly Singular Integral Equations with Abel Type Kernels

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Abstract

The first discovery of fractional integration was by Abel [1,2] while trying to solve the well-known tautochrone problem. Because of the singularity of the kernel of obtained integral equations by Abel with variable integration limits, in addition to being called as first and second kind Volterra integral equations [3], they are also called as singular and weakly singular integral equations with Abel-type kernels [4]. The idea of solving an integral equation with known boundary conditions using Riemann sums was first revealed by Rall [5]. In this study, solutions of singular integral equations and solutions of weakly singular integral equations are treated through a numerical scheme by pursuing the way of Rall [5].

Keywords: Singular Integral Equations, Weakly Singular Integral Equations, Riemann Sums

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Novel Hybrid Particle Swarm Optimization for Unconstrained Optimization Problem

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Abstract

In this study, we adopted a novel hybrid global–local optimization algorithm called NPSOG, which combines particle swarm optimization (PSO) [1] and a gradient method [2,3] to solve a class of global optimization problems for continuously differentiable functions.

In this method, at each iteration of the PSO algorithm, and under specific condition given by the notion of loudness parameter, we perform an exploitation step by a gradient method. The loudness parameter was *introduced in first time by* Yang in *[3]*.

Our experimental results for the test functions indicate that the usage of NPSOG algorithms can improve the performance of PSO considerably. In addition, its performance as a viable optimization method is demonstrated by comparing it with classical kind of hybridization.

Keywords: Particle swarm optimization, Nonmonotone gradient method, Bat Algorithm.

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Design of Textile Pattern Categorization Using Hough Transform

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Abstract

Nowadays, there are enormous amount of textile images in textile industry and the images are increasing very fast. For quickly finding the searched textile images we have to classify the images in textile collections. We also need to categorize these images automatically because manually classification is very hard, boring and time-consuming process.

Hough Transform is mathematical transformation which is used for detection of lines and circles in images. The point coordinates (x,y) in edge part of images are transformed to (rho,theta) Hough parametric space and the maximum accumulation points represent the lines.

In this study, we have designed and implemented textile pattern categorization systems [1-2] using Hough Transform which detects line segments and circles in the images. The systems consist of four main parts: Preprocessing, Feature Extraction, Training and Testing. In preprocessing operation, after each image is converted to grayscale image, binary images are constructed with edge detection operator (Sobel operator). Then, Hough Transform is applied to all binary images. In feature extraction phase, each image in the textile dataset is represented as an array of circle and line pattern frequency. The dataset includes seven patterns as "flowery", "spotted", "plaided", "horizontal striped", "vertical striped", "46 degree striped" and "135 degree striped". Using training dataset, the systems are trained with the state-of-the-art categorization methods as Random Forest (RF) [3], Support Vector Machine (SVM) [4] and K-Nearest Neighbor (KNN) [5]. After that, we have tested and evaluated the systems. In testing, the success of the system is calculated by using textile patterns in testing datasets and the class models developed in the training phase. Accuracy and F-measure values are used for computing the success of the systems. According to accuracy and F-measure, the best results of the systems which are evaluated with 10-fold-cross-validation technique, are obtained with RF. The best RF accuracy and F-measure results are 85.6% and 85.4%.

Keywords: Hough Transform, Textile Pattern, Random Forest, Support Vector Machine, K-Nearest Neighbor.

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A New Fractional Differencing Algorithm for ARFIMA

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Abstract

In the present paper a new differencing algorithm is presented and it is applied on analysis of time series. In a recent paper, a new fractional discretization formula for fractional derivative is constructed by Tarasov [1]. This new discretization of fractional derivative is different from the classical Lubich discretization [2]. New method satisfies some important properties as universality and algebraic correspondence. So, it is an exact discretization. Motivated by the idea of using this new method for improving the models where Lubich approximation is commonly used, we consider fractional differencing part in the (Autoregressive fractionally integrated moving average) ARFIMA model. It is known that ARFIMA (p,d,q) technique is different from classical (Autoregressive integrated moving average) ARIMA model, because the researcher is able to choose the fractional order of differencing d to ensure that the resulting series is a stationary process. ARFIMA method is important due to the fact that many time series exhibit long-range dependence, but they can not fit to any ARIMA model. The ARFIMA model is designed to represent these series. So, we consider the generalized version of ARIMA which is ARFIMA with a new fractional differencing algorithm.

The new fractional differencing approach truncates the series by assuming some data zero. The method is generated by some modifications on the fractional derivative approach in [1]. The reason is the loss of a huge amount of data in direct implementation of truncated series. The second important reason is that direct method can differentiate the first half part of the data in this form. But in time series analysis forecasting is important and desired. So a new fractional discretization form is proposed and the new ARFIMA (p,d,q) technique is applied on some biostatistical data. Relevant theory, obtained results and comparisons with classical approach is demonstrated throughout the paper. Results support the importance and usefulness of the new method.

Keywords: Fractional differencing, ARFIMA, Time Series

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Bi-Objective Optimization of an Unrelated Parallel Machine Scheduling Problem with Sequence-Dependent Setup Times

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Abstract

Parallel machine environments are widespread due to the fact that there are several machines that encounter the same job in the workshop environment. One of the most important issues that integrates the machine scheduling problem with the real life cases and enhances the applicability of model is the set-up times. They include work required to prepare a machine to produce parts of a given type, including setting jigs and fixtures, adjusting tools, and other material [1]. In this paper, a similar version of the unrelated parallel machine scheduling problem with sequence-dependent setup times that has been formulated in the literature was addressed in a multi objective manner [2]. A multi-objective programming model has been considered to minimize the number of tardy jobs and the total completion time of all the jobs as the first and the second objectives, respectively. A schedule that optimizes one objective may perform quite poorly for another. Therefore, evaluation of the trade-offs between several objectives is so important. At this point, consideration of multi-objective decision making techniques is rather essential [3]. While some techniques in the literature consider the objectives in a sequential manner, we used a simultaneous approach. In this work, LP-metric method was used to optimize the objectives as an LP-metric objective function. The model has been coded with GAMS 24.6.1 software and solved on an Intel(R) Core(TM) i5-2430M CPU 2.40GHz processor with 4 GB RAM. The results obtained were compared with the results of classical weighted sum scalarization method. Suggestions for future work have been presented.

Keywords: Scheduling, multi-objective optimization, LP-metric method

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Reduced Order Optimal Control of Gierer-Meinhardt Equation

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Abstract

We compare three different model order reduction techniques with Galerkin projection: the proper orthogonal decomposition (POD), POD-DEIM (discrete empirical interpolation) and POD-DMD (dynamic mode decomposition) for solving optimal control problems governed by Gierer-Meinhardt equation. The Gierer-Meinhardt equation consists of the activator and the inhibitor components, and it has pattern formation solutions in form of spots and stripes.

The POD and POD-DEIM reduced optimal control problems are nonconvex due to the nonlinearity in the reaction terms. DMD is an equation-free, data driven method which extracts dynamically relevant information content without explicitly knowing the dynamical operator [1]. We use DMD as an alternative method to DEIM [2] in order to approximate the nonlinear term in the Gierer-Meinhardt equation. Applying the POD-DMD Galerkin projection gives rise to a linear system of equations for the equation, and the optimal control problem becomes convex. We compare the accuracy and CPU times of three reduced order methods with respect to the full order discontinuous Galerkin finite element solutions for spot and stripe pattern formations.

Keywords: Gierer-Meinhardt equation, optimal control, discontinuous Galerkin method, proper orthogonal decomposition, discrete emprical interpolation, dynamic mode decomposition

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Numerical Solutions of ODEs with Dirichlet Boundary Conditions via Recurrent Neural Networks

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Abstract

In this paper, we numerically solve Dirichlet Boundary Value Problems for linear and nonlinear second order ordinary differential equations using simple Recurrent Neural Networks proposed by Jeff Elman [1]. Neural Networks generate the solutions for every point in a search space, not just for quadrature points obtained via discretization of the search space. For this reason, Neural Networks (NNs) have been an alternative method in place of traditional numerical methods, recently [2,3].

In this study, we use an unsupervised learning technique on the recurrent neural network to learn the solution of a differential equation with Dirichlet Boundary Conditions. The nonlinear activation functions such as hyperbolic tangent, Rectified Linear Unit (ReLU), Leaky RELU, Parametric Rectified Linear Unit (PReLU), Exponential Linear Unit (ELU) and Self-gated activation function (SWISH) are used [4] to improve the network model and to avoid the vanishing gradient problem [5].

According to No Free Lunch (NFL) theorem [6], it is stated that no optimization algorithm outperforms any other algorithm in general. Therefore, we use some variants of Particle Swarm Optimization [7-9] to train the recurrent neural network with cross-validation. The obtained results have been analyzed in detail, and compared with each other.

Keywords: Recurrent Neural Network, Particle Swarm Optimization, Differential Equations, Dirichlet Boundary Value Problems.

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Analytical Solving Some Fractional Differential Equations Using New Extension Sub-Equation Method

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Abstract

This work presents a new analytical perspective for solving some fractional order differential equations. For this purpose, we are going to consider space-time fractional Foam Drainage equation, space-time fractional Bogoyavlenskii equation and space-time fractional Telegraph equation by using a simple and efficient method which is called as sub-equation method in extended form. Symbolic programming, wave transformation, and the above-mentioned method enable us to obtain three different types of exact solutions as trigonometric, hyperbolic and rational. As a result, the considered method is straightforward, concise and powerful. It can be applied to a wide range of evolution equations which have integer and fractional order.

Keywords: New extension sub-equation method, Conformable, Bogoyavlenskii equation, Foam Drainage equation, Telegraph equation, analytical solutions.

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Green Vehicle Routing Problem in a Logistics Company

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Abstract

One of the most important operational decisions in logistics management is to determine the vehicle routes that will serve the customers. The Vehicle Routing Problem (VRP) deals with finding the possible distribution or collection routes to a variety of demand points from a central warehouse in order to minimize the total distance traveled by the vehicle fleet. Increased environmental awareness in legal and social contexts has enabled the handling of factors that affect the environment in the problem of vehicle routing. Although the adverse effects of carbon dioxide (CO_2) accumulation in the atmosphere on the greenhouse effect are well known in the past, studies to remove these effects have increased in recent years. The most important international regulation for this purpose is the Kyoto protocol. With this protocol, the countries have introduced legal emission reduction obligations [1]. Accordingly, annual CO_2 emissions of each country are of great importance. This requires countries to calculate the CO_2 amounts. Thus, a sustainable distribution network can be created using less energy and less damage to the environment. Therefore, the Green Vehicle Routing Problem (GVRP), a new type of vehicle routing problem, aims to design a route that takes into account environmental factors such as fuel consumption and CO_2 emissions, unlike the traditional approach [2]. A lot of studies have been done on the green vehicle routing problem and mathematical models have been established to minimize fuel consumption [3]. In this study, it has been tried to minimize the total fuel consumption of the logistics companies that are transporting for some of the provinces located in Eastern Anatolia and Central Anatolia region. For this study, a mathematical model was established considering the limitation of a daily working period which is a social constraint, not exceeding nine hours. The established model is solved as VRP with different time windows by means of a solver program.

Keywords: Vehicle Routing Problem, Vehicle Routing Problem with Time Window, Green Vehicle Routing Problem, Mathematical Model.

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Applications of a New Expansion Method for Finding Wave Solutions of Nonlinear Differential Equations

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Abstract

In this paper, we presented a new expansion method constructed by taking inspiration for the Kudryashov method. Bernoulli equation was chosen in the form of $F' = BF^n - AF$ and made some expansions on the auxiliary Bernoulli equation which used in this method. In this auxiliary Bernoulli equation, by taking n = 3, some wave solutions obtained from Burgers equation and the shallow water wave equation system. As a result, for special values, we concludedthree dimensional wave views for solutions of Burgers Equation and the shallow water wave equation system. To sum up, it is considered that this method can be applied to other nonlinear evolution equations in mathematics physics.

Keywords: A new expansion method, Kudryashov method, travelling wave solution, Burgers equation, system of the shallow water wave equation.

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An Optimization Model for the Energy Efficient Job Shop Scheduling Problem with Machine State and Time-Of-Use Electricity Tariffs of Turkey

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Abstract

In recent years, there has been a growing concern on environmental impacts of traditional manufacturing regarding carbon emissions and energy consumption [1]. Moreover, the energy prices are rising continuously and new environmental standards put more pressure on the manufacturing industry over the last decade [2]. As a result, energy efficient scheduling has been attracting increasing attention by the manufacturing industry during the last years. In this study, we investigate a bi-objective job shop scheduling problem with time-of-use electricity tariffs. Two objectives namely, makespan and energy consumption cost are normalized and merged with equal weights. In this context, a mixed integer linear programming (MILP) model is proposed. Hourly real electricity prices from Istanbul Energy Market are employed to calculate the cost of electricity. Further, different machine states (i.e. idle, turning up, in operation, turning down, stand by and off) and corresponding energy consumption rates are taken into account similar to the study of [3]. The efficiency of proposed model enables decision makers to determine the machine state at each period. The proposed model is solved through the MPL modeling system 5.0 which calls Gurobi 7.5.1 solver and tested over different benchmark problems. The results reveal that energy efficient scheduling with hourly energy prices may significantly reduce the energy consumption cost while maintaining acceptable makespan values. The optimal schedule could help factories minimize the production expenditure.

Keywords: Job shop scheduling, makespan, energy consumption cost, machine state, time-of-use electricity tariffs.

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Total Sound Press Level and Polynomial Interpolation in the e-Studio

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Abstract

e-Studio is a platform that provides active participation of students who take lessons from universities/institutions that provide online (synchronous) training for distance education. This is a model designed and developed to increase the success of distance education by using and adapting educational technology at the highest potential in this environment. In this study, the total sound press level for the sounds generated by the sound sources in the e-studio was calculated with a software developed and an interpolation polynomial model was created.

Keywords: e-Studio, sound press level, polynomial interpolation.

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Using numerical method for third order fractional partial differential equation

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Abstract

In this paper, we consider initial boundary value problem for fractional partial differential equation

$$\begin{cases} \dfrac{\partial^3 u(t,x)}{\partial t^3} + \dfrac{\partial^\alpha u(t,x)}{\partial t^\alpha} - \dfrac{\partial^2 u(t,x)}{\partial x^2} + u(t,x) = f(t,x), \;\; 0 < x < L, \;\; 0 < t < T, \\ u(0,x) = \varphi(x), \;\; \dfrac{\partial u(0,x)}{\partial t} = \Psi(x), \;\; \dfrac{\partial^2 u(0,x)}{\partial t^2} = \sigma(x), \;\; 0 \le t \le T, \\ u(t,X_L) = u(t,X_R) = 0, \;\; X_L < x < X_R \,. \end{cases}$$

For this problem, basic definitions are given. For the exact solution of this problem, stability inequilities are investigated. The first order of difference schemes of the problem are constructed. Stability estimates for the solution of difference schemes for initial-boundary value problem for fractional partial differential equation are obtained. The theoretical expressions for the solution of these difference scheme are supported by the results of numerical examples. The results of numerical experiments are presented, and are compared with analytical solutions. These results obtained with Matlab programming showed that the method gives good results for this problem. (See references [1], [2] and [3])

Keywords: Fractional differential equation, stability, numerical solutions

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Fuzzy Multi Criteria Decision Making Approach Integrated Mathematical Model for Examination Timetabling Problem

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Abstract

Examination timetabling is one of the most important problems in the education systems of universities. This problem aims to assign a set of examinations of university courses to timeslots while satisfying problem specific constraints [1-4]. In this study, we introduce a fuzzy multi criteria decision making approach integrated mathematical model formulation for the examination timetabling problem to create a balanced exam schedule. In proposed solution methodology, first, the weights of the courses are determined to identify study load of the students for each day in exam schedule. To evaluate the weights of the courses, a fuzzy TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) method is employed by taking into account a set of criteria, such as, course credit, number of the students registered for the course, theoretical group of the course, etc. In fuzzy TOPSIS method, the weights of the courses are determined by using linguistic terms introduced by Chen [5]. Following the fuzzy TOPSIS evaluation process, the examination timetabling problem is solved by using a mixed integer linear programming (MILP) formulation, in which the weights of the courses are used in the objective function to minimize maximum weight difference between the scheduling days. Furthermore, the technological restrictions for the exam plans are considered in the mathematical model. The performance of the proposed solution methodology is tested on a problem set which is formed by using the past data of a department in a public university. For each benchmark problem, the input data of the fuzzy TOPSIS are determined according to the experience of the instructors. Further, the MILP model was implemented in the MPL Modeling System 5.0 and solved by using Gurobi 7.5.1 solver. Computational results reveal that the proposed solution methodology is capable of obtaining more efficient and balanced examination plans when compared to the past examination plans.

Keywords: Examination timetabling, multi criteria decision making, TOPSIS, fuzzy sets, mixed integer linear programming

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Selection of Solar Energy Plant with Large-scale Group Decision Making under Hesitant Fuzzy Linguistic Assessment

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Abstract

The consensus in group decision making (GDM) problems is to provide a common agreement from individual opinions with situational evaluation. The method of obtaining consensus in the group decision-making process with different disciplines and a large number of participants leads to the emergence of large-scale group decision-making (LGDM) problems. The increase in the number of decision makers in the group leads to an increase in intellectual diversity and the difficulty of obtaining consensus from the decision-making group. New methods have been developed for solving such decision-making problems arising from intellectual expansion and intellectual diversity (Quesada, Palomares, & Martinez, 2015; Xu, Du, & Chen, 2015). Wu and Xu's study (Wu & Xu, 2018), which is developed as an alternative to these studies focusing on non-cooperative behaviors, aims to reach a common idea level by dynamic clusters obtained by changing individual preferences. The contribution of the study to solve the LGDM problems is as follows: the use of the possibility distribution based hesitant fuzzy element (PDHFE) probability distribution method, the expansion of the k-means clustering method to define the consensus framework for the consensus process in LGDM, the design of the local feedback strategy to raise decision makers' preferences to compromise level.

Solar energy systems, which have environmental sensitivity and low operating costs as an alternative energy source to fossil fuels, require high installation costs. Therefore, high-tech solar energy systems must be installed in the right conditions and in the right place (Crawley, 2016). Determining the right installation location of solar power plants with high installation costs is an important decision making problem. In this study, decision making problem for the installation of photovoltaic solar energy system is implemented by using LGDM method proposed by Wu and Xu. Five alternative regions are assessed by twenty-five decision makers with the help of hesitant fuzzy linguistic expressions (Rodriguez, Martinez, & Herrera, 2012) and the most appropriate region is determined by the fuzzy logic-based decision making model.

Keywords: Large-scale group decision making, solar energy, hesitant fuzzy linguistic assessment

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Some Common Fixed Point Results via Implicit Contractions on Soft Quasi Metric Spaces

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Abstract

The concept of soft quasi-metric space, according to soft element and some of its properties are given very recently by Bilgili Gungor [1].(In review). It was noticed that in the symmetric case, many fixed point theorems on soft G-metric spaces are particular cases of existing fixed point theorems in soft metric spaces. But for treating the non-symmetric case, Bilgili Gungor [1] introduced soft quasi-metric space and showed that non-symmetric soft G-metric space have a soft quasi-metric form and then many results on non-symmetric soft G-metric spaces can be reproduced from fixed point on soft quasi-metric spaces. Otherwise, Popa ([2],[3]) started and worked the concept of fixed point for mappings satisfying an implicit relation. And many researchers proved so many fixed point theorems for mappings satisfying several types implicit relations. In this paper we will define an implicit contraction mapping via soft real numbers inspired from the article of Popa and Patriciu [4] and we give some common fixed point results involving implicit contractions on soft quasi metric spaces. And we also prove the well posedness of the common fixed point problem. Finally, we indicate that some fixed point results on soft G-metric spaces are immediate consequences of our main theorems on soft quasi metrc spaces.

Keywords: Common fixed point, soft metric space, soft quasi metric space, soft G-metric space, implicit contractions,

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Analysing of Solar Energy Pricing Process with Hesitant Fuzzy Cognitive Map

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Abstract

Solar energy systems, which are the most important alternative to fossil fuels, take place in the energy sector with high initial cost and low operating costs. Price is an important competitive factor in the development of renewable energy systems and in providing a competitive advantage in the energy market. Solar energy systems must have a price advantage in order to be able to compete with other renewable and traditional energy types (Timilsina, Kurdgelashvili, & Narbel, 2012). The national and international factors that determine solar energy prices in the energy market include temporal and spatial uncertainty. The correct definition of solar energy prices in the long term has an important influence on solar energy investment decisions. In this study, political, economic and social factors affecting solar energy price are defined and causal relations between these factors are applied in Hesitant Fuzzy Cognitive Map (HFCM) model (Çoban & Onar, 2017; Kosko, 1986; Torra, 2010).

The causal relationships between the factors and the initial state values of the factors are assessed linguistically based on the knowledge, skills and experience of the experts. The linguistic expressions determined by the experts are initially converted to Hesitant Fuzzy Linguistic Term Sets (HFLTSs) (Rodriguez, Martinez, & Herrera, 2012) and then transferred into Trapezoid Fuzzy Membership Functions (TFMFs). The weight matrix and initial state vector values obtained by defuzzifying the TFMF expressions are used to simulate the HFCM model (Çoban & Onar, 2017). The obtained solar energy price based HFCM model is simulated through different initial state scenarios and the equilibrium state values of the factors are calculated for each scenario. The results obtained under different scenarios show that the identified factors have a significant effect in determining solar energy price. The simulated HFCM models indicate different equilibrium state values for the factors in different scenarios and the solar energy price appears to be long term adaptation to the energy price market. Factors that directly affect the solar energy price play an important role in the model as it moves to equilibrium state. Energy supply, energy demand and energy price factors are fundamental factors that make the model dynamic and affect renewable and non-renewable energy prices, especially solar energy price. The general equilibrium states of the simulations show that the new solar energy generation systems are developed in market conditions without any incentive mechanism.

Keywords: Solar energy price, hesitant fuzzy cognitive map, hesitant fuzzy linguistic term sets

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Reinvestment Decisions for Wind Energy Projects

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Abstract

The need of human beings to use energy resources continues to increase day by day. The use of wind energy which is one of the renewable energy sources is an important alternative to supply the need for energy worldwide. Investment efficiency is very important issue before and during the investment period due to the fact that wind energy investments are high cost investments. In this study, a solution proposal will be developed for the replacement of inefficient wind turbines which are established. In the ideal solution of the topic, the remaining life time of the wind turbine which is to be replaced and capacity utilization at the new place of turbine will be used as key input factors.

Keywords: Energy, wind energy, energy investment decisions

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Symmetry Methods of Flow and Heat Transfer between Slowly Expanding or Contracting Walls

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Abstract

An analysis has been carried out for the flow and heat transfer of an incompressible laminar and viscous fluid in a rectangular domain bounded by two moving porous walls which enable the fluid to enter or exit during successive expansions or contractions. The basic equations governing the flow are reduced to the ordinary differential equations using Lie symmetry analysis. Effects of the permeation Reynolds number, porosity, and the dimensionless wall dilation rate on the self-axial velocity are studied both analytically and numerically.The solutions are represented graphically.The analytical procedure is based on double perturbation in the permeation Reynolds number and the wall expansion ratio, whereas the numerical solution is obtained using Runge-Kutta method with shooting technique. Results are correlated and compared for some values of the physical parameters. Lastly, we lookat the temperature distribution.

Keywords: Lie symmetry analysis, perturbuation, flow and heat transfer.

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A New R Programming Package for the Detection of Outliers in Univariate Time Series Data

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Abstract

The outlier detection is one of the fundamental steps in the data analyses. Hereby, from univariate and multivariate to high dimensional datasets, there are many outlier detection methods developed from different research groups [1, 2]. Some these approaches are also supported by the R programming packages which are publicly available such as "mvoutlier" [3] and "outliers" [4] packages and some of these techniques can be found under certain thematic R packages for example the "mvBACON" function under the "robustX" package [5]. Accordingly, in this study, we introduce a novel R package for the detection of outliers for univariate time series datasets. The package is based on the application of a recent method, called FOD (Fourier transform-based outlier detection) [6], for this type of measurements. In the package, the users can find the outliers by using this method for their datasets. Additionally, they can also simulate data from various distributions under different sample sizes and percentage of outliers periodically or aperiodically. Here, the periodicity and aperiodicity imply the outliers that can be lied throughout the observation set as the former case or can be seen only a part of the complete data as the latter case. Furthermore, in the package, we can visualize the location of outliers in the measurements under various graphs. Moreover, these analyses can be also done via z-score and box-plot methods as the two most common outlier detection approaches in the related literature. Finally, in order to show the application of these methods, we also prepare 2 datasets and illustrate the outcomes of each preference in the FOD and other functions. On conclusion, we consider that our R package can help the users to detect the outliers in a significantly accurate, fast and user-friendly way with respect to its close alternatives.

Keywords: Outlier detection, R package, visualization, time series data, Fourier transform.

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Detection of Binding Sites of Chip-seq Data via Hidden Markov Model and Frequentist Inference of Model Parameters

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Abstract

The hidden Markov model (HMM) is one of the major modeling approaches that is based on the graphical representation in the form of a chain. In this structure, we have a sequence of multinomial "state" nodes which are hidden and a sequence of observations that are produced by the states [1]. In order to construct the link between the states and observations, different types of inference methods are suggested in the literature. For instance, the EM algorithm or the Baum-Welch forward-backward algorithm [2] and the Viterbi algorithm [3] are two well-known approaches in this field. In this study, we apply the frequentist methods in order to model different Chip-seq datasets. Basically, the experiments of the Chip sequence are performed to locate the DNA bindings sites which are occupied by promoters, enhancers, repressors and insulators. By using this dataset, it is possible to detect the bindings sites of genome which has the spatial dependency between neighboring sites (or windows). This information can be important, for example, to determine the point of amino acid physicochemical properties since the co-localized amino acid sequences must share some similarity, and hereby, to determine the protein tertiary structure [4]. Hence, in this work, we perform two alternative frequentist ways to find the underlying binding sites of publicly available datasets. For the first approach, we propose to accept the measurements as the observed states and the core physicochemical features of the data which are obtained by the feature extraction as the hidden states in HMM. Once the associated feature vectors, which denote the peptides, are estimated, we investigate which pair of amino acid position is suitable for binding. On the other hand, for the second alternative approach, we consider to define the bindings site as a separate parameter in the estimation via the constructed HMM above. Finally, we compare the accuracy of both results by validating the findings with known literature. We think that such frequentist inference may open new avenues in the determination of protein structures and better understand certain diseases which are dependent on the binding affinity.

Keywords: Hidden Markov model, frequentist inference, protein tertiary structure, biological network.

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Ecology and Evolution of Vector-Borne Diseases in a Multi-Scale Model

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Abstract

There is recent interest in mathematical models which connect the epidemiological aspects of infectious diseases to the within-host dynamics of the pathogen and immune response. Multi-scale modeling of infections allows for assessing how immune-pathogen dynamics affect spread of the disease in the population. Here, we consider a within host model for immune-pathogen dynamics nested in an age-since-infection structured PDE system for vector-borne epidemics. First, we study pathogen-host coevolution by analytically establishing evolutionary stable strategies for parasite and host, and by utilizing computational methods to simulate the evolution in various settings. We find that vector inoculum size can contribute to virulence of vector-borne diseases in distinct ways [1]. Next, we develop a robust methodology for identifiability and estimation of parameters with multi-scale data, along with sensitivity analysis. The nested multi-scale model is fit to combined within-host and epidemiological data for Rift Valley Fever. An ultimate goal is to accurately model how control measures, such as vaccination and drug treatment, affect both scales of infection [2].

Keywords: age-since-infection structured PDE model, stability analysis, identifiability

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Neutral Differential Systems of Fractional Order with State-Dependent Delay

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Abstract

In this work, by employing the fractional theory, noncompact measure and Mönch's theorem, we investigate the existence results for neutral differential equations of fractional order with state-dependent delay. An illustration of derived results is offered.

Keywords: Noncompact measure, Mönch fixed point theorem, Neutral equations, state dependent delay

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Structural Design Optimization through Water Cycle Algorithm with Evaporation Rate

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Abstract

Generally, the optimization techniques utilized in structural design optimization could be categorized into two main groups such as classical and metaheuristic search methods. The first groups, namely classical optimization methods such as linear programming, nonlinear programming and optimality criteria, often require substantial gradient information. The initial selected points have directly effect on the final solution and the computational operation number rises depending on the increment of the size of the structure [1]. Usually, the most of the real-world structural engineering designs are complicated and their solutions require more sophisticated methods than conventional mathematical methods to be handled. Because of this requirement, new recent trend optimization techniques which are so-called metaheuristic search methods are evinced. These methods do not need any initial data as in the conventional mathematical programming and have preferable global search talent than the classical optimization algorithms [2]. The last addition to the metaheuristic algorithms is denominated as Water Cycle Algorithm (WCA). The principal idea behind WCA is observation of water cycle process and how rivers and streams flow to the sea [3]. In order to enhance the global search ability of WCA, a new concept of evaporation rate for different rivers and streams is defined so-called WCA with evaporation rate (WCA-ER) [4]. The WCA-ER reveals a better balance between exploration and exploitation phases compared to the standard WCA. It is shown that the WCA-ER offers high potential in finding all global optimum of structural design problems in which the weight minimization is treated as objective function while satisfying the certain design constraints. The WCA and WCA-ER are tested using several structural design problems and the obtained results show that the WCA-ER obtained minimum design weight and converges to the global solution faster. According to the optimum designs yielding via WCA-ER, the efficiency of the proposed method on structural design optimization problems are represented.

Keywords: Optimal structural design, metaheuristic search techniques, water cycle algorithm.

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Grasshopper Optimization Algorithm Based Design of Structures

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Abstract

The topic of optimization is accepting vital care from engineers, scientists, managers, and designers. This is goaded by arise the rivalry of quality, assurance, economical cost of production, and at the end, the success of obtaining the best design. Thus, nowadays, the practice of optimization could not be ruled out. The inescapable further development of desktop computing resources significantly aids engineering design practice currently. Optimization algorithms are implemented via software programs and through computer codes they can be simply applied to three-pipe problems such as structural design optimization problems. Successfully embedding the use of optimization in professional practice requires mathematical modeling of the design problem and knowledge of optimization techniques. This provides a huge opportunity for handling complex mathematical background of hard solving engineering design problems in an easy manner [1]. So, the design engineers are supplied by a practical approach to the study of design optimization by these practical optimization algorithms which are so-called metaheuristics. On the contrast of the conventional mathematical optimization methods, the metaheuristics does not require any gradient-based information and not suffer from local optimal immersion. Also, they have popular talent to solve the problems with large number of unknown and/or computationally expensive derivation. The main advantageous of metaheuristics is that they trust random operators that provide them to keep away from local optimal. Among metaheuristic optimization approaches, nature-inspired, population-based algorithms are the most popular [2]. Such techniques mimic natural problems-solving methods, often those used by creatures. Survival is the main goal for all creatures. To achieve this goal, they have been evolving and adapting in different ways. In this study, a grasshopper optimization algorithm [3], which is mathematically modelled and mimicked the swarming behavior of grasshoppers in the nature, is developed to obtain optimum solutions of three-dimensional structural design problems. The final achieved designs prove that the proposed algorithm is able to provide superior results compared to well-known and recent algorithms in the literature.

Keywords: Structural design optimization, metaheuristics, grasshopper optimization algorithm

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Comparison of the Stabilized Finite Element Solutions of Optimal Control of Convection Diffusion Equation

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Abstract

In this work, we consider the comparison of the stabilized finite element (fem) solutions of optimal control of convection diffusion equation. We consider

$$\begin{aligned} minimize \quad J(y,u) = & \frac{1}{2}\int_{\Omega}\|y-y_d\|^2dx + \frac{\alpha}{2}\int_{\Omega}\|u\|^2dx \\ subject\ to \quad & -\nu\Delta y + \beta.\nabla y + \alpha y = u + f \quad in\ \Omega, \\ & y = 0 \qquad on\ \partial\Omega, \end{aligned}$$

where y and u are called state and control variables, respectively. y_d is given and called as desired state. α is the regularization paramater [1].

We first obtain the optimality conditions [2]. Then, we state the weak form of the optimality system. We apply fem to get the discrete problem [3]. Because of the viscosity term in the problem, fem solutions blow up depending on the value of the Reynolds number. To avoid this, we use different stabilization methods. The most popular stabilization technique to handle convective terms is known as SUPG [4]. Moreover, we consider grad-div stabilization. This technique has been recently used in convective problems. Grad-div stabilization adds a penalty term with respect to the continuity equation to the momentum equation [5]. We present and compare the results. We use the package freefem++ to get the numerical solutions.

Keywords: Optimal control, stabilized fem, convection diffusion equation.

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A Semi-Lagrangian Scheme for Numerical Solution of Advection-Diffusion Equations

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Abstract

In this study an unconditionally stable semi-Lagrangian scheme is proposed for the numerical solution of advection-diffusion equation. The proposed method is based on the Saulyev method and the method of characteristics with cubic spline approximation. The convergence of the proposed method has also been studied. To confirm the results obtained from the analysis several numerical examples have been discussed. It is revealed that the proposed method provides highly accurate as well as efficient solutions.

Keywords: Advection-diffusion; Operator splitting; method of characteristics; cubic spline interpolation; Saulyev scheme.

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Complex Conformable Derivative and Integral

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Abstract

The standart mathematical models of integer order derivatives is not sufficient for some real world applications. At this stage, fractional calculus arises a powerfull method to characterize such problems in science and engineering. There are many fractional derivative operators in the literature with their applications such as Riemann-Liouville, Caputo which are nonlocal operators with singular kernels [5-7]. Due to some difficulties encountered in applications of these operators, Khalil [1] has been defined a limit based fractional derivative for real functions. It is a local operator named as conformable fractional derivative and effective to solve fractional differential equations analytically. The basic properties of this operator has been introduced by Abdeljawad [2] and then many authors has been studied this operator in terms of basic concepts of classical analysis [2-3].

Both of local and nonlocal fractional operators has been extensively studied for real functions but they are rarely seen in the complex plane. Therefore, we define complex conformable derivative operator for complex functions and examine some properties of this operator such as conformability.

Keywords: Complex conformable derivative, complex conformable integral, conformability.

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Behavior of Fractional Derivative Operators Defined on Two Different Kernels in Nonlinear Equations

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Abstract

Recently, fractional differential equations (FDEs) have attracted much more. Since most FDEs do not have analytical solutions, approximation solution techniques are used commonly. Therefore, in this study, we have demonstrated a new approximate-analytical solution method namely Laplace homotopy transform method (LHTM) using two different fractional derivative operators (FDOs). This method is obtained by combining Laplace transform (LT) and homotopy perturbation method (HPM). We have used FDO suggested by Caputo-Fabrizio (CF) in 2015 based on the exponential kernel and Atangana-Baleanu (AB) operator developed in 2016. The AB operator has been described with the generalized Mittag-Leffler function in the meaning of non-locality and non-singularity of the kernel. We have regarded as the LHTM with both derivatives in order to compare their results in linear and nonlinear problems. Moreover, convergence and stability analysis have been constructed of the model. According to the results of this study, it can be concluded that the LHTM in CF and AB fractional derivative sense is an effective and accurate method which is computable the series easily in short time. Also the method is much easier than other homotopy methods, so the LT allows one in many positions to eliminate the inadequacy essentially caused by insufficient boundary or initial conditions that take part in other approximate-analytical methods like HAM.

Keywords: Atangana-Baleanu fractional derivative, Caputo-Fabrizio fractional derivative, Homotopy perturbation method, Laplace transform, Nonlinear equation

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Complex Conformable Derivative and Rolle's Theorem

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Abstract

It is well-known that Rolle's and Mean value theorems have many consequences in classcical analysis and have been used in some application problems such as nonlinear equations, optimizations, economics [1, 2, 5]. But these theorems are not valid for holomorphic functions of a complex variable [3, 5]. Evard and Jafari [3] was presented a generalization of Rolle's Theorem to holomorphic functions of a complex variable and shown how Mean value theorem for holomorphic functions obtained from this theorem. Moreover, there are many results and applications of these theorems such as the relations between the zeros of the real, imaginary parts of the derivative of a holomorphic function and the zeros of that holomorphic functions [3,4].

In this study, we define the notion of an α - holomorphic fuctions of a complex variable and give Rolle's and Mean value theorems for α - holomorphic fuctions. Also, we give the equivalence of these Rolle's and Mean value theorems.

Keywords: α -holomorphic function, complex conformable Rolle's theorem, complex conformable Mean value theorem.

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Identifying of the Solutions of Nonlinear Fractional Differential Equations with Caputo-Fabrizio Operator in Banach Spaces

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Abstract

During the last years, new fractional derivative operators have been defined such as conformable, Caputo-Fabrizio and Atangana-Baleanu. They have been used in modelling the fractional partial differential equations and describing certain problems such as diffusion processes, chemistry, engineering, economic, material sciences and other areas of application. Knowing existence and uniqueness of solutions a problem is more important than modeling it. In this context, the aim of this work is to give theorems about the existence and uniqueness of the solutions of the fractional differential equations involving the Caputo-Fabrizio derivative with nonlocal initial condition in Banach spaces. Moreover, at the end of this work, an example is given to demonstrate the applicability of our results.

Keywords: Existence-uniqueness conditions, nonlinear differential equations, Caputo-Fabrizio fractional derivative, Banach space

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Exploiting the Impact of the Migration Operator Used in the Adaptive Genetic Algorithm in Optimization Problems of Complex Systems

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Abstract

It has been supported by studies that parallel genetic algorithms developed for the purpose of solving distributed problems are far more successful than genetic algorithms. The most important factor contributing to this success is the migration operator. Migration is the phenomenon of moving a certain number of individuals from one subpopulation to another periodically[1,2]. In this study, the Genetic Algorithm and the developed Adaptive Genetic Algorithm are used to solve complex system optimization problems[3-5].

The biggest problem encountered is that these algorithms are prone to getting stuck in *local bests*. Therefore, the migration operator has been added to the Genetic Algorithm and the Adaptive Genetic Algorithm in order to avoid local bests and to ensure that these algorithms search in wider area of the large search space of complex systems.

When the Genetic Algorithm is used, It has been observed that the complex system data optimization process is frequently fitted to local optimizations over a period of time. Because of the limited number of individuals, the populations are filled with the same set of solutions in a short period of time. This is the proof that optimization process are fitted to the local best.

In this work, we have tested these algorithms using the migration operator in different complex system models such as ecological systems model, lotka volterra. When the obtained results are examined, it is observed that the Adaptive Genetic Algorithm with migration operator is much more successful than the Genetic Algorithm and the targeted success is achieved in complex system optimization.

Keywords: Complex Systems, Genetik Algorithm, Adaptive Genetic Algorithm, Migration Operator, Optimization.

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3D Finite Element Modeling of the Nonlinear Behavior of Confined Masonry Walls

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Abstract

Confined masonry walls are generally preferred systems in structures such as buildings. Masonry is a composite material made of masonry blocks (brick, stone etc.) and mortar. Modeling is one of the efficient ways of analyzing a structure in the closest way to the truth. Numerical models can be used for designing masonry structures and verification of experiments on masonry structures. The finite element analysis (FEA) is extensively preferred numerical technique to model masonry structures. In this study, nonlinear structural behaviors of confined masonry walls are modeled and analyzed with using 3D finite element models. Macro modeling technique known as homogenization is used for modeling of the masonry part of the confined walls in ANSYS software. The interaction between the exterior frame of the structural system and the masonry wall are modeled with using contact and target elements. The analytical structure of using the contact and target elements are presented in detail [1]. The Willam-Warnke failure hypothesis, a suitable hypothesis for materials which have high compressive strength but having low tensile strength, is used to determine the fracture mechanisms of the confined masonry walls. The selected modeling technique, the material model and the fracture hypothesis form a combination to model the confined masonry walls numerically. The results obtained by the 3D finite element analysis on the confined masonry walls were found to be compatible with the experimental results in the literature. By using the finite element analyzes presented in this study, confined masonry walls can be successfully determined using the contact and target elements. It was seen that; confined masonry walls had generated dramatically more durable structure than masonry walls without confined frame systems.

Keywords: Contact, Finite elements, Masonry

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Investigation of the Structural Design Parameters of Masonry Walls Based on Nonlinear Finite Element Analysis

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Abstract

Masonry is one of the earliest structure types of the history. These walls are composite structures that can be modeled using advanced techniques such as numerical methods. Modeling of the masonry structures is a necessary to understand their structural behavior. Designing of masonry structures and verification of experiments on the masonry structures, numerical models can be used efficiently. The finite element analysis (FEA) is a robust numerical technique to analyze masonry structures. In this paper, nonlinear behaviors of heterogenous masonry walls under the effect of in-plane loads are numerically modeled and analyzed with ANSYS software [1]. The masonry units such as bricks, stones or etc. and mortar between the masonry walls are modelled as detailed heterogenous modelling. A parametric analysis is performed to investigate the structural design parameters of masonry walls via nonlinear finite element analysis. The effect of aspect ratio on the masonry wall, the effect of mortar thickness and masonry units are analyzed numerically based on finite element method. The Willam-Warnke failure hypothesis, a suitable hypothesis for materials which have high compressive strength but having low tensile strength, is used to determine the material properties of the masonry wall. The combination of selected modeling technique, the material model and the fracture hypothesis are successfully performed for masonry wall models. Remarkable results were obtained for investigation of design parameters of masonry walls. Strength values of the walls are determined as result of the parametric analysis on the walls. By using the finite element modeling approach presented in this study, masonry walls which have distinct design parameters can be successfully and practically analyzed.

Keywords: Finite elements, Heterogenous, Parametric

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Numerical Solutions of Linear Fractional Differential Equations with Delay Obtained by Using Euler Polynomials

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Abstract

In this study, a method based on both Euler polynomials and matrix collocation method is proposed to solve fractional order linear differential equations with delay [1,2]. The proposed method yields an approximate series solution expressed in the truncated series form

$$y_N(x) = \sum_{n=0}^{N} a_n E_n(x^\alpha)$$

where a_n, $n = 0,1,...,N$, are unknown coefficients to be determined and $E_n(x)$ $n = 0,1,...,N$, $N \geq m_1$, are the Euler polynomials which are explicitly defined by

$$\frac{2e^{xt}}{e^t + 1} = \sum_{n=0}^{\infty} E_n(x) \frac{t^n}{n!}, \quad n = 0,1,2,...$$

Combining the matrix and collocation methods matrix method developed by Sezer et. al.[4]. By this study, the matrix method developed for linear fractional differential equations in [3] is extended for fractional differential equations with delay. The proposed method is applicable to all equations which are also subset class of linear fractional differential equations with delay by just ignoring the unrelated terms from the algorithm. Some numerical examples are given to demonstrate the efficiency of the proposed method.

Keywords: Euler Polynomials, Fractional Differential Equations, Collocation Method, Delay.

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Optimized Taylor-Euler Series Solutions for Linear Volterra-Fredholm Integral Equations with Delay Terms

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Abstract

The solutions of linear Volterra-Fredholm integral equations with delay terms [1,2] are obtained in the series form after calculating the coefficients of it and combining with Euler polynomials. In the view of proposed matrix formulations, replacing matrix correspondence to the integral equation leads to the system of algebraic equations in which the collocation points are already used as in [3,4]. Solving this system of equations for the coefficients gives an approximate series solution expressed in the truncated series form consisting of the coefficients and Euler polynomials. The proposed method can be used easily for integral equations with delay and in order to show the applicable of it, some examples are also given.

Keywords: Euler polynomials, integral equations, collocation method, delay, Volterra, Fredholm.

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FPGA Based Synchronization by Using Adaptive Control Method of Two Different Chaotic Systems

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Abstract

In this paper, chosen two different chaotic systems have been synchronized using adaptive control method and sent to FPGA(Field Programmable Gate Array) for real-time results. Complex synchronization method has been preferred as the synchronization method. Also as master system, Lorenz Chaotic System and as slave system, Chen Chaotic System have been preffered. An adaptive synchronization controller based on Lyapunov stability theory has been designed to control all system. Then Matlab/Simulink program has been used to run the system with FPGA.

The change of the error was investigated by the obtained simulation and real-time results. Finally the results show that the simulation and real-time results of the system overlap each other.

Keywords: Chaos, chaos synchronization, adaptive control, fpga

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$\left(\frac{G'}{G}\right)$-Expansion Method and Its Application to Whitham-Broer-Kaup-Like Equations

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Abstract

The wave solutions of Whitham-Broer-Kaup-Like (WBKL) equations, which describe the bi-directional propagation of long waves in shallow water small-amplitude regime, with different dispersion relations, is evaluated by (G'/G)expansion method. The WBKL equations are reduced into one nonlinear partial differential equation (NLPDE) via Miura transformation and the hyperbolic function and trigonometric function solutions of NLPDE are obtained.

Keywords: WBKL equations, (G'/G)-Expansion Method, Miura transformation, soliton solutions.

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Developing a Mathematical Model for CBTC System and Safe Braking Distance Calculation

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Abstract

This paper represents Communications-Based Train Control(CBTC) system, which is based on moving block signalling. Eventually, in this control system Automatic Train Operation(ATO) subsystem, which is based on driverless vehicle control, is experimented. In this system, the trains are moved by communicating each other using wireless connection. In this way, faster rail traffic flow is ensured, especially in metro lines. In this study, the trains are modeled as a MIMO system with mass-spring-damper model. Then, a driving force is applied to this system as an input and a speed profile is obtained from this output. For two train model, speed profiles, nose locations and tail locations of trains are compared with this algorithm. According to this study, safe proceeding of these trains is obtained. After that, Relationships between speed profiles and distances of trains are showed. Finally, safe braking distance between these trains is calculated, when trains are stopped at any station. This calculation is solved depending on speed of the rear train. So, the faster the rear train, the longer safe braking distance must be. Besides, a safety margin distance is defined for safe stopping at the station. In simulations prepared using Matlab-Simulink™, train models, speed profiles, locations, accelerations, forces and relationships are showed.

Keywords: CBTC system, mass-spring-damper model, speed profile

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Modeling and Simulation of an Autonomous Wheelchair with Control Purposes

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Abstract

This paper presents mathematical modeling and simulation of an autonomous wheelchair with control purposes, which constitutes an important part of a research project on vision-based smart wheelchair control and navigation. Currently available electric wheelchairs fail in satisfying the needs of disabled people in many cases such as neuromuscular disabilities, reflex disabilities, etc. Additionally, wheelchair outdoor navigation encounters high risk and serious challenges. The project aims to solve mobility problem of disabled people by adding visual information technology and efficient motion control and navigation design to standard electric wheelchair. To achieve this goal, first the mathematical model of wheelchair dynamics is built in such a way that it describes the main characteristics and dynamical behavior of system. A computer simulation model is developed to observe the results of the study. The simulation is implemented in three steps. Firstly, linear model of DC motor is extracted and analyzed for right and left wheels of the wheelchair in the simulation. Secondly, mathematical model of the chassis of chair is obtained and linearized. Lastly, integration with dynamic model of DC motor is completed by using system parameters. Inertia of body and internal resistance of motor are found experimentally. Back emf constant K_v, torque constant K_t are calculated. Effects of disturbances like rolling resistance, axle friction and air drag are analyzed. Also, influences of rider mass are shown on left and right motors. Using the results of simulation tests, control algorithm is developed for efficient motor control. Linear displacement, position control, direction control and velocity of wheelchair are presented in the computer simulation results. In conclusion, it is revealed that obtained mathematical model is capable of representing autonomous wheelchair dynamics in open-loop and closed-loop and simulation results prove effectiveness of the model and designed control system. Results of the study will be used in the research project that aims to solve the autonomous wheelchair control problem.

Keywords: Autonomous wheelchair, mathematical modeling, simulation, wheelchair control.

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A Flower Pollination Algorithm for Improving Cluster Analysis

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Abstract

Cluster analysis is a popular data analysis and data mining technique. Clustering helps reveal hidden structural relationships in data. In the literature, many clustering methods have been proposed so far. Among plethora of clustering methods which have been proposed so far, k-means clustering is the widely preferred algorithm mainly due to its simplicity and practicality. Despite its many advantages, k-means clustering has some drawbacks. One of the shortcomings of k-means clustering algorithm is that its performance is highly dependent on the initial solutions, and the algorithm traps into local optima. In this study, flower pollination algorithm, which is based on the flower pollination behavior in nature, is employed in order to identify the best clusters without trapping into local optima. Flower pollination algorithm is a member of swarm intelligence-based metaheuristics. Flower pollination behavior stems from the purpose of reproduction. From the evolutionary perspective, the objective of flower pollination is the survival of the fittest and the optimal reproduction of species. All the factors and processes of flower pollination interact with each other in order to achieve optimal reproduction of the flowering plants. Among other swarm intelligence based metaheuristics such as ant colony algorithm, particle swarm optimization or immune systems, flower pollination algorithm exhibits superior performance in many numerical optimization problems. However, flower pollination algorithm is very little issued in the clustering literature. In this study, flower pollination algorithm is carried out in order to improve k-means clustering algorithm. The performance of the proposed approach is analyzed by using the standard benchmark problems which are taken from the UCI machine learning repository. The initial results have showed that the proposed approach improves the traditional k-means algorithm.

Keywords: Flower pollination algorithm, cluster analysis, global optimization

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A Cultural Algorithm for Mechanical Design Optimization

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Abstract

The real life engineering problems are hard to be solved optimally due to some strict limitations of the classical optimization techniques. This difficulty is mainly due to the fact that the inherent search procedures of those techniques are based on local search mechanisms that are designed for certain class of problems. In other words, problem specific constraints, objective function formation and type of decision variables make the engineering optimization quite challenging area. Furthermore, the performance of the classical optimization techniques is heavily related to structure of the solution space. For instance, convexity or concavity of the solution space compel finding out suitable solution techniques or revising the model representation, viz. constraints or objective function. To sum up, it is difficult to generalize a classical solution approach for all types of optimization problems. In addition, most of the real life problems including design optimization problems inherently involve diverse types of variables, constraints and objective functions simultaneously. For that reason, metaheuristic algorithms have been widely employed in handling real life design optimization problems. The cultural algorithm is one of the population-based metaheuristic algorithms that mimics social evolution and learning in agent-based societies. In the cultural algorithm, the experience of population of agents are integrated into a belief space consisting of various forms of symbolic knowledge. The two basic components of the cultural algorithms are population space and the belief space. In each generation of the algorithm, individuals of the population are evaluated with respect to objective function. Then, some of the individuals are allowed to change their belief space and the belief space is updated based on the experience of the individuals. Furthermore, belief space is allowed to influence the selection of individuals for the next generations. The feedback mechanism between population and belief space is one of the distinct aspects of the cultural algorithms. In this study, a set of mechanical design problems are studied and the performance of the cultural algorithm is tested. The design of a tension/compression coil spring, design of a pressure vessel, and design of a welded beam problems are solved by cultural algorithms. The cultural algorithms have proved to be efficient and effective for engineering optimization design.

Keywords: Cultural algorithm, global optimization, mechanical design.

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Wind Farm Layout Optimization for Minimum Wake Loss

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Abstract

In the case of a wind farm design the wake interactions between wind turbines are one of the most critical subject that has to be considered. The wake in downstream is characterized by a deficit in wind speed and increased in turbulence. So, the downstream turbines cannot produce expected power from the wind anymore [1]. In this paper, the main concern is finding the best layout in terms of maximum power production. A wind turbine placement model is addressed for a 350m x 1000m rectangle shaped site. The hourly average wind speeds and directions for a whole year have been supplied from a 10m met mast in this area. A topographic map is used to obtain the data of terrain. First, wind farm's geographic position data which are latitude, longitude and elevation are generated by scanning a topographic map. A set of 1568 scanned point data are collected. The latitude and longitude values in the data set are both angles in radians, while corresponding elevations are in meters. In order to eliminate this incompatibility, latitude and longitude values of the terrain are transformed into geodesic distances by the formula of Vincenty. Thus, the data set turned into a three dimensional Cartesian coordinates in metrics. Each coordinate of terrain is considered as a possible turbine location, and the terrain is not discretized in a matrix as in many studies proposed. The solution starts with a heuristic which is based on wind shear while keeping the minimum distance between two turbines. Here, the aim is, to locate the first turbine to the highest point instead of first row of the terrain, since the highest point has the highest wind speed [2]. So, based on elevation values an initial population obtained heuristically. The genetic algorithm is then proposed to find an optimal placement of wind turbines considering to minimize the wake loss. This mainly depends on the number of wind turbines, wind speed and direction, characteristics of terrain and wind turbine features. Different parameters are evaluated, and the results of velocity deficits and total power output in each case are presented and compared.

Keywords: Micro-siting, wake loss, wind farm layout optimization, optimal placement.

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Design of Experiment Setup for Fractional Order Chaotic Systems

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Abstract

Chaos and chaotic systems are one of the most popular topics in the recent years. One of the reasons for chaos to be very popular is it can be applied in different fields of studies like communication, encryption, control and finance etc. Another application field of chaos is physical realization and electronic circuit modelling of chaotic systems. The chaotic systems can be categorized into two: fractional order and integer order chaotic systems. The physical realization of chaotic systems are quite difficult due to their very sensitive and complex nature. There are many studies in the literature regarding this issue [1-3]. However, the most of the realized studies are on the integer order chaotic systems [4-5]. The studies on the fractional order chaotic systems are very rare. One of the reasons is the realization of the fractional order chaotic systems are very difficult than that of the integer order chaotic systems. All the dynamics phenomena we encounter in the real world and their properties can be defined almost exactly with the fractional order systems. This makes the investigation of the fractional order chaotic systems very meaningful. In this study, an electronic card is designed for easy realization of the fractional order chaotic systems. With the designed electronic card, both integer and fractional order chaotic systems can be easily realized and their results can be obtained via an oscilloscope. In the future studies, many different fractional order chaotic systems will be realized to show that the fractional order chaotic systems and their applications can be used in different engineering fields.

Keywords: Chaos, chaotic systems, fractional order nonlinear systems, electronic circuit design.

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Modeling and Optimizing of the Intelligent Traffic Light system by using PLC

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Abstract

This paper presents the implementation of a traffic light control system by using PLC [1]. TIA Portal program is used to adjust the appropriate duration between the traffic lights according to the traffic jam. Traffic lights give safety to the users on roads [2]. The main objective of this paper is to obtain the model and application for a suitable algorithm and its simulation for an intelligent traffic signal flow. Mathematical modeling can be used to describe the real-world phenomena and make predictions about the real-world. The developed system is able to sense the presence or absence of vehicles within a certain range by setting the appropriate duration and using sensor data. Traffic load is highly dependent on parameters such as time, day, season, weather and unpredictable situations such as accidents, special events or construction activities [3]. If these parameters are not taken into account, the traffic control system will create bottlenecks and delays. The proposed intelligent traffic control system solves these problems by continuously sensing and monitoring traffic conditions and adjusting the timing of traffic lights according to the actual traffic load. Mathematical functions are used to calculate the appropriate timing for illuminating of the green light [4]. The timing can be written according to the traffic flows in a day but it is exactly not to solve the traffic jam [5]. The critical timing operation is required to be carried out under the existence of heavy traffic conditions. Optimization of traffic light cycle in the roads with regard to the timeframe and traffic volume causes the increasing of traffic management quality. Another important aspect is to decrease of gas emission pollution. The PLC checks the status of the sensors according to the intelligent traffic control algorithm written by experts. After that it provides output signals to the traffic lights for ON or OFF the red, yellow or green lights. PLC provides fast automation and effective optimization of traffic light control system. SIEMENS S7-1200 PLC and ladder logic program are used for controlling the lights in the system [6].

Keywords: Intelligent traffic lights, traffic control, mathematical model, optimization, PLC

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Nonlinear Analysis and Circuit Realization of Chaotic Aizawa System

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Abstract

The chaos theory which has been working theoretically and practically for the past several decades, has been adapted to many physical systems [1-5]. High complexities and unpredictable behaviors are essential characteristics of a chaotic system. Sensitive dependence on initial conditions is another important feature of a chaotic system. In this work, nonlinear analysis and circuit realization have been held for revealing dynamic characteristics of chaotic Aizawa System [6]. The nonlinear characteristics are investigated via time series, phase portraits, lyapunov exponents and bifurcation diagrams. Circuit realization is also applied for sketching dynamic behaviours of Aizawa attractor.

Keywords: Chaos, chaotic systems, Aizawa system, nonlinear analysis, bifurcation, electronic circuit realization.

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Conformable Fractional Optimal Control Problem with Transversality Condition

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Abstract

Recently, a new and interesting definition has been proposed as an alternative fractional derivative operator by expanding the conventional limit definition of the classical derivative [1]. This local fractional operator, named as conformable fractional derivative, has been generalized with the left and right derivative approaches and also the higher order conformable fractional derivatives have been given, [2]. Many researchers have shown that some fundamental properties of the classical derivative are provided for conformable fractional derivative. Therefore, fractional differential equations with conformable fractional derivative became easily solvable with analytical ways [3]. This advantage of conformable fractional derivative leads quick applications of the conformable fractional differential equations to the real world problems both in the view of modeling [4, 5] and control [6, 7].

In this work, in addition to the necessary condition obtained in [7] the transversality condition is initially obtained for calculus of variations with conformable fractional derivatives. Then, the transversality condition is acquired for optimal control problems from the Hamiltonian formalism in which the optimal control problem is defined with a conformable fractional performance index subject to a conformable fractional dynamic system whose end-point is not fixed. The process is applied to find the optimal control of a diffusion equation defined with time-conformable fractional derivative. The optimal control law is achieved by using eigenfunction expansions of state and control and solving analytically the arising time dependent conformable fractional ordinary linear differential equation. The results are plotted by using MATLAB.

Keywords: Conformable fractional derivative, calculus of variations, optimal control, transversality condition.

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Modeling of Chaotic Motion Video with Artificial Neural Networks

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Abstract

In this study, a chaotic motion is modelled using artificial neural networks can be created again. Chaotic signals can occur many fields like natural affairs, communication, encryption, finance, health [1, 2]. Artificial neural networks, fuzzy models, hammerstein model can be used to predict these types of signals as well as to provide a mathematical form to be modelled [3-6]. As an example of the motion that will be modelled in this study, there may be movement of an second order inverted pendulum, movements of balls on a billiard table, or phase diagrams of such systems. However, the phase diagram of the most basic Lorenz chaotic motion is preferred. The image position of the point or object that is followed in sequential images are determined by image processing techniques [7]. By using the position information obtained from these images, they are trained with backpropagation algorithm to artificial neural networks, which is NARX structure. NARX structures is constructed with two inputs, two outputs. Its first layer contains 100 neurons and second structure contains 20 neurons. Subsequently, NARX artificial neural networks were tested to try to get chaotic motion videos again. As a result, some chaotic signals, sequential images, or videos can be modelled with artificial neural networks instead of being mathematically modelled and reproduced.

Keywords: Chaos, chaotic systems, artificial neural networks, image processing.

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Agent-based Hormonal Regulation of Blood Glucose Levels Using Negative Feedback Control Mechanism

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Abstract

In this paper, we describe the hormonal regulation of blood glucose levels by agent-based modeling and simulation. Agent-based modeling and simulation is a technique in simulating and exploring phenomena that includes a large set of active components represented by agents. The agents perform specific tasks depending on rules of agents' actions and interactions in agent-based simulation environment. The goal of this study is to introduce and visualize the process by which the blood glucose levels are regulated by negative feedback control mechanism in order to maintain homeostasis inside the human body. We use to the negative feedback control mechanism with agent-based modeling approach to regulate the secretion of hormones which are responsible for increasing or decreasing the blood glucose levels. In order to implement negative feedback control mechanism, we offer three main agents which play important roles in the hormonal regulation of blood glucose levels. We develop our study in Repast Simphony platform which is Java based modeling system. Repast Simphony provide us a graphical user interface. By using Repast Simphony platform, we create our scenario tree including displays of agents, grid and continous space, data sets, data loaders, histogram and time charts. In the result of this study, we analyse the local behavior of the agents in the negative feedback loop and observe graphically how the blood glucose levels achieve normal levels. It is thought that this regulatory system which developed by effective modeling approach may contribute to the observation and analysis of other homeostatic control systems inside the human body.

Keywords: Agent, Agent-based modeling and simulation, homeostasis, negative feedback control, blood glucose levels.

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New Exact Solutions for the Drinfeld-Sokolov Equation Using an Improved Bernoulli Sub-Equation Function Method

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Abstract

In this study, the application of the improved Bernoulli sub-equation function method to the Drinfeld-Sokolov system is presented. Some new solutions are successfully constructed. All the obtained solutions in this study satisfy the Drinfeld-Sokolov model. We carried out all the computations and the graphics plot in this paper by Wolfram Mathematica 9.

In this paper, the Drinfeld-Sokolov (DS) system of equations [1-2] is investigated by using the improved Bernoulli sub-equation function method [3].

The Drinfeld-Sokolov (DS) equation is given by

$$\begin{aligned} u_t + (v^2)_x &= 0 \\ v_t - av_{xxx} + 3dvu_x + 3kv_x u &= 0 \end{aligned} \tag{1}$$

where $u = u(x,y,t)$, $v = v(x,y,t)$ and a, d, k are constants.

Various analytical approaches have been used in obtaining the exact solutions to the the Drinfeld-Sokolov (DS) system of equations. Wazwaz [4] used the sine-cosine and tanh method to DS, El Wakil and Abdou [5] used the modified extend tanh-function method for finding exact solutions for five model of nonlinear differential equations, one of which is the DS system. Zangh et al. [6] used the complex system for complex DS system.

Keywords: Drinfeld-Sokolov system of equations, Improved Bernoulli sub-equation function method

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Chaos Extension in Coupled Lorenz Systems

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Abstract

The dynamics of unidirectionally coupled Lorenz systems [1] is investigated. It is rigorously proved that chaos can be extended from one Lorenz system to another. The extension of period-doubling cascade [2,3] and sensitivity [1,4], which is the main ingredient of chaos, are shown both theoretically and numerically. Moreover, the emergence of cyclic chaos and intermittency are considered for interconnected Lorenz systems. The results are valid if the drive Lorenz system is chaotic and the response system is non-chaotic, but admits a global asymptotically stable equilibrium or a globally attracting limit cycle.

The principal novelty of our investigation is that we create exogenous chaotic perturbations by means of the solutions of a chaotic Lorenz system, plug it into a regular Lorenz system, and find that chaos is inherited by the solutions of the latter. Such an approach has been widely used for differential equations before, but for regular disturbance functions. That is, it has been shown that an (almost) periodic perturbation function implies the existence of an (almost) periodic solution of the system.

Our approach can shed light on how global weather processes have to be described through mathematical models. A possible connection of the results with the global weather unpredictability is provided.

Keywords: Lorenz system, Chaos extension, Unidirectional coupling

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Poincaré Chaos in Non-autonomous Equations

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Abstract

The starting point of the present study is the unpredictable point [1], which is a new object for the dynamical systems theory. We apply the topology of uniform convergence on compact sets to define unpredictable functions [2,3], which are compulsorily accompanied by Poincaré chaos. The topology is metrizable and easy for applications with integral operators. The unpredictable sequence is defined as a specific unpredictable function on the set of integers.

This study contributes to the theory of chaos as well as to the theories of differential and discrete equations such that the existence and uniqueness of the unpredictable solution are proved for a delay differential equation as well as quasilinear discrete systems. Besides illustrative examples that support the theoretical results, Poincaré chaos near periodic orbits is shown and an application to Hopfield neural networks [4] is provided.

In our opinion, a new field to analyze in the theory of differential equations has been discovered. Since many results of differential equations have their counterparts in discrete equations [5], one can suppose that theorems on the existence of unpredictable solutions can be proved for discrete equations. The present study is a one that realizes the both paradigms. The existence and uniqueness theorems for quasilinear delay and ordinary differential equations as well as difference equations have been proved, when the perturbation is an unpredictable function or sequence. This is visualized as Poincaré chaos in simulations.

Keywords: Unpredictable solutions, Poincaré chaos, Differential equations, Discrete equations

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Period-doubling Route to Chaos in Systems with Impulsive Effects

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Abstract

One of the routes to chaos is the period-doubling cascade, which was first observed in quadratic maps [1]. This phenomenon is based on the successive emergence of periodic motions with twice period of the previous oscillation as some parameter is varied in a system [2,3]. A critical parameter value exists at which the process accumulates, and beyond the critical value the system possesses chaotic motions [2]. Period-doubling route to chaos can be observed in systems of differential as well as discrete equations [3,4].

In this study, we investigate the formation of chaotic dynamics through period-doubling cascade in systems of differential equations with impulses. Impulsive differential equations describe the dynamics of real world processes in which abrupt changes occur [5]. This type of equations are important from the applications point of view since they can be used for modelling in many fields such as mechanics, electronics, biology, neural networks, communication systems, and population dynamics [5]-[8]. We rigorously prove the existence of infinitely many unstable periodic solutions, and provide illustrative examples that support the theoretical results.

Keywords: Period-doubling cascade, Impulsive differential equations, Chaos

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Third Order Impulsive Boundary Value Problems on Time Scales with Positive Solutions

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Abstract

The theory of time scales, which was introduced by Hilger [1] to unify continuous and discrete analysis, has received a lot of attention among mathematicians. This theory has many applications in various disciplines such as mechanics, electronics, neural networks, population models, and economics [2]-[5]. Boundary value problems with integral boundary conditions have been the subject of investigations along the line with impulsive differential equations because of their wide applicability in various fields [6,7]. This study is devoted to positive solutions of a third-order impulsive boundary value problem with integral boundary conditions on time scales. Using four functionals fixed point theorem [8], sufficient conditions for the existence of at least one positive solution is obtained. Examples that support the main results are provided.

Keywords: Positive solutions, impulsive boundary value problems, time scales.

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Feedback Linearization Control of a 2DOF Helicopter

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Abstract

This paper presents the design procedure of a feedback-linearization-based nonlinear control law for a harware-in-the-loop 2DOF helicopter platform. The subject of control methods for aerial vehicles that are capable of vertical take-off and landing are studied because of having important role on fire detection, border patrol, etc. [1]. In the literature, there are several types of controllers tested on the this particular platform. Neural control is proposed in [1], neuro-fuzzy control designed and tested in [2], adaptive controller is shown to be adjusting itself to mass and inertia changes in [3].

In this paper, the authors present a feedback-linearization-based control for a 2DOF helicopter test platform. First the mathematical model of the system is obtained. The physical parameters such as mass, inertia, frictional coefficients are known. In order for the system to respond like an second order overdamped system, pitch motion is defined as a second order homogeneous differential equation including a parameter, lambda. The second derivative of pitch angle is put on the left hand side of the equation, and the others on the right. The first derivative of the pitch angle, and pitch angle terms are on the right hand side and are used in the feedback law. The same procedure is done for the yaw angle. The second derivative of the pitch and yaw angles are taken as virtual inputs and these virtual inputs are included in the nonlinear mathematical model of the system. The equations are solved for the motor voltages and thus the control law is obtained. The mathematical model should be close to the real system because the control law includes model parameters. This method is implemented on the actual system and results show that the system is driven to stability.

Keywords: helicopter, nonlinear control, feedback linearization,

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Computational Fluid Dynamics Analysis of the NASA S-Duct Intake

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Abstract

In the current study, a Computational Fluid Dynamics analysis is performed for the NASA S-duct intake case. This reference case is an experimental study conducted in the Lewis Research Center [1]. The experiment was performed by following steps: First, five cross-sectional planes were positioned on centerline and these planes included pneumatic probes. Three-dimensional velocity field, static and total pressures were obtained for these planes by using pneumatic probes. The flow parameters in the test were Mach number 0.6 and Reynolds Number 2.6 million. Thu current CFD results will be compared with the experimental data in reference study.

The study will start with the creation of the S-Duct based on the four non-linear equations which define the geometry. Three of these equations will be used for the centerline distribution and the other one for the calculation of the radius with respect to the center line [2]. The given geometry equations will be solved with Matlab software and the geometry will be created using the Solidworks software based on the data of the solved equations by Matlab. The geometry will be meshed using the Ansys Meshing software. The compressible Navier-Stokes equations for turbulent and compressible flow conditions are solved using the ANSYS Fluent software. Then the numerical results will be compared with the experimental data. The main purpose of this study will try to find the optimized numerical setup for the NASA S-Duct intake geometry which is a very critical design problem for the military purpose aircraft.

Keywords: NASA, S-Duct, subsonic flow, CFD

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Time Optimal Control of a Reaction Wheel Actuated System

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Abstract

This paper presents the time optimal control design for a reaction wheel actuated system. Reaction wheels are mostly used in the space applications [1], as an actuator for attitude maneuvers [2], [3] and also for energy and momentum storage [4]. Spacecrafts can be controlled by these devices precisely [1]. In this paper, prior to aerospace application, hardware-in-the-loops tests are conducted for a reaction wheel. A flywheel of diameter 10cm and of thickness 2mm is designed and manufactured. It is mounted on an electric motor, the system can rotate around one axis. When the motor is accelerated, this creates a reaction torque on the system and it rotates in the opposite direction of the rotation of the flywheel. Similarly, as it is decelerated, a reaction torque in the opposite direction acts on the system. The angular velocity of the flywheel (ω) is measured for different voltages applied on the motor, also the time required to reach the maximum velocity (t_1) and the time from maximum velocity to zero (t_3) are known. If a reference angle is given (θ_{ref}), and the initial angle (θ_0) and initial angular velocity ($\dot{\theta}_0$) of the system is known, with the information, t_1, t_3 and ω_{max}, the time to maneuver from initial angle to final angle can be calculated solving a second order linear ordinary differential equation. There are three phases of this operation, in the first phase, the wheel accelerates to maximum velocity in t_1 time, in the second phase, the wheel is at maximum speed (ω_{max}), in the final phase, the wheel decelerates to zero speed in t_3 time. The time required to stay in the second phase is t_2 and this is to be calculated knowing the reference angle. This procedure is applied and the results show that the system can be driven to reference angle with small error by using this method.

Keywords: reaction wheel, spacecraft control, attitude maneuver, momentum exchange

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Numerical Investigation of Flash-Mounted Duct for Subsonic and Transonic Flow Regimes

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Abstract

In this study, a numerical investigation is carried out for the NASA flush-mounted S-duct intake case for the subsonic and supersonic flow regimes. The referenced study is an experimental study carried out in the NASA Langley Research Center 0.3-Meter Transonic Cryogenic Tunnel. In that study, for the validation of the computational analysis, the OVERFLOW software was employed [1]. The experimental tests were conducted in wind tunnel through mounting intakes on the wind tunnel wall to simulate the boundary layer ingestion. The Mach numbers were changing from 0.25 and 0.83 and the Reynolds numbers from 5.1 million to 13.9 million. The mass flow ratios were varying from 0.29 to 1.22. The four S-duct intake models, namely Inlet-A, B, C, and D, were designed to integrate into the aircraft which required flush-mounted intakes. The experimental data of Inlet-A will be used in the study to compare the numerical results. The geometry parameters of S-duct with Inlet-A were described in four graphs which belong to the centerline distribution, cross-sectional areas, super-ellipse shape parameter, and dust aspect ratio for each section quadrant with respect to distance downstream beginning with the throat. The solid model of Inlet-A, as sketched in Ref. [2], will be sketched by using Solidworks by lofting 20 sections and the grid will be created using ANSYS Meshing. The subsonic and transonic Navier-Stokes equations for this flow problem will be solved using ANSYS Fluent software. The objective of this study is to compare the data of CFD and experimental study and hence to validate the flow solver.

Keywords: NASA, flush-mounted S-Duct, subsonic flow, transonic flow, CFD.

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Concreteness and Likeliness of Design and Optimization Stages

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Abstract

This study brings a view to engineering design process and optimization stage in order to improve equipment/system functions, economical manners, and time-saving measures. The first part tries to summarize standardized engineering design processes. The second step of the study puts discussions about optimization of design stages that improve expectations from the equipment or the system. The third section is for exemplification of the approach with a case study. This shows all junctions of the design stages and optimization stages via a case design.

Keywords: Design, optimization, case study.

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Supersonic CFD Analysis of a Mach 2.65 Mixed-Compression Axisymmetric Intake

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Abstract

In this study, the flow through a supersonic axisymmetric intake will be simulated using ANSYS Fluent flow solver. The numerical data obtained from CFD analysis will be compared to the experimental data. The reference experimental study was performed at NASA Ames Research Center's wind tunnel facilities as expressed in Ref. [1]. The main purpose of the current study is to calculate the performance and capacity of the intake and compare the results with the Mach number of 2.65. The test model was 1/3 scale model of main supersonic intake and the diameter of the model cowl lip is 49.723 cm. This supersonic intake model is created using Solidworks as shown in Fig.1.

The meshing of the geometry will be created using ANSYS Meshing and the Navier-Strokes equations for the corresponding supersonic compressible turbulent flow will be solved using ANSYS Fluent software. The governing equations are shown in Eqs. (1-3) as expressed in [2].

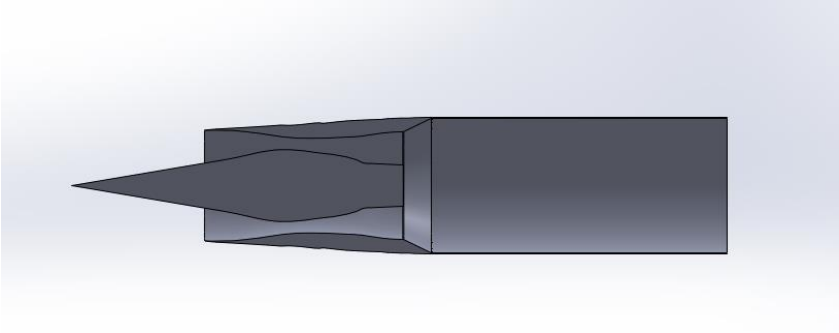

Figure 1: Cross section of geometry design of the axisymmetric intake in Solidworks.

$$\frac{\partial \rho}{\partial t} + \frac{\partial (\rho u_i)}{\partial x_i} = 0 \tag{1}$$

$$\frac{\partial (\rho u_i)}{\partial t} + \frac{\partial (\rho u_i u_j)}{\partial x_j} = \frac{\partial p}{\partial x_i} + \frac{\partial}{\partial x_j}\left[\mu\left(\frac{\partial u_i}{\partial x_j} + \frac{\partial u_j}{\partial x_i} - \frac{3}{2}\delta_{ij}\frac{\partial u_l}{\partial x_l}\right)\right] + \frac{\partial}{\partial x_j}\left(-\rho\overline{u_i' u_j'}\right) \tag{2}$$

$$\frac{\partial \rho \overline{h_s}}{\partial t} + \frac{\partial \rho \overline{u_i} \overline{h_s}}{\partial x_i} - \frac{\partial \bar{p}}{\partial t} - u_j \frac{\partial \bar{p}}{\partial x_i} - \frac{\partial}{\partial x_i}\left(\lambda \frac{\partial \bar{T}}{\partial x_i}\right) = \frac{\partial}{\partial x_j}\left[\rho\left(\overline{u_i h_s} - \overline{u_i}\,\overline{h_s}\right)\right] \tag{3}$$

Keywords: Axisymmetric Intake, Supersonic Flow, CFD

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New Exact Solutions for the Doubly Dispersive Equation Using an Improved Bernoulli Sub-Equation Function Method

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Abstract

Nonlinear evolution equations (NLEEs) are widely used to model various nonlinear complex phenomena arising in different field of nonlinear sciences, such as; optical fibers, fluid dynamics, fluid mechanics, plasma physics, condense matter physics, nonlinear dispersive media among others [1–4]. As the NLEEs describe various aspects of our real-life situations, its therefore important to seek for their solitary wave solutions [5]. The doubly dispersive equation is an important nonlinear physical model describing the wave propagation in the nonlinearity elastic inhomogeneous Murnaghan's rod. In this paper, the application of the improved Bernoulli sub-equation function method to the doubly dispersive equation is presented. Some new solutions are successfully constructed. Under the suitable choice of the values of parameters, the 2D, 3D and the contour graphics of some secured solutions are plotted.
The doubly dispersive equation [6] is given by

$$\emptyset_{tt} - \left(\frac{1}{\rho}(E\emptyset)_x\right)_x = \frac{\epsilon}{2}\left(\frac{1}{\rho}(p\beta\emptyset^2 + pv^2\emptyset_{tt} - (b\alpha v^2\emptyset_x)_x)_x\right)_x \quad (1)$$

where $b = \frac{M}{E} < 1, p = \frac{B}{E}$ are combinations of the constant scale factors.

Keywords: Doubly Dispersive Equation, Improved Bernoulli sub-equation function method, Exact solutions

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A Cost-Benefit Analysis on Ship Speed Optimization

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Abstract

Maritime sector is a comprehensive branch of industry with its numerous fields of application and various operation processes. Because approximately 90 % of world trade is handled by maritime trade, it plays an indispensable role on world trade network. Although the great capacity that maritime trading system can manage, the success of the system is strongly bound to some factors such as absolute punctuality, safety and cooperation of shareholders. In order to obtain satisfactory benefits from the trading process, the ship must depart from and arrive to the ports just in time. For timing is totally depends on ship speed, speed optimization has a crucial importance for ships. Nevertheless, ship optimization, which has impacts on fuel consumption, ship flue gas emissions and general operation costs, is a multidimensional issue.

The speed of a ship is optimized during design stage; however, in some cases, the design speed may not be optimal speed due to the time constraints. While very high speeds are costly because of greater fuel consumption and increased engine size and weight, slow speeds extend the time between the scheduled voyages [1]. Although it is well known that speed reduction is an important way to reduce CO_2 emissions, this method has some constraints, as well. Lindstad et al., (2011) [2] investigated the impacts of speed reduction on emission reduction and general costs. It is concluded that the emissions can be reduced by 28 % with zero cost. On the other hand, if the emission reduction amount increased to 33 % and 36 %, 20 $ and 50 $ must be spent per ton CO_2 reduction, respectively. According to the suggestions of the authors, there must be no speed limits for ships which must escape from pirates and navigate in harsh weather. Corbett et al., (2009) [3] concluded that reducing the speed by 50 % can provide a 70 % CO_2 reduction; however, 20 % reduction of CO_2 cause 30-200 $ cost per ton CO_2 reduction. Cariou, (2011) [4] concluded that speed reduction provided a 11 % reduction on emissions during the period of 2008-2010; however, it is also indicated that this method is only accepted as sustainable if the fuel prices are lower than 400 $.

Ship speed optimization brings some uncertainties besides its remarkable benefits. Although it can be accepted as an important way to reduce emissions, it must be updating for every voyage and condition.

Keywords: Ship speed optimization, fuel consumption, cost-benefit analysis

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Queuing Theory Applications in Maritime Transport

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Abstract

Transportation is the process of transferring a person or a commodity from one place to another. There are factors such as time, distance, cost and safety that need to be taken into account when carrying out the transportation operation. The means of transportation have shown tremendous progress since the beginning of civilization. Along with the increased need for transportation, those who want to meet their transportation needs also have the desire to make transportation operations at less cost, shorter time, and higher security.

In parallel with the intensive use of maritime transportation, ship traffic in the sea is increasing. This increased traffic brings many accidents at sea. With the increase in marine traffic, intensive ship traffic occurs in the straits. Also, ships waiting for loading and unloading at the ports also constitute a maritime traffic and this traffic is both dangerous and brings extra cost. Inefficient use of ports can not only result in loss of port competitiveness but also increase the volume of polluting ship emissions [1]. In order to solve these problems in maritime transportation, some studies have been done with the queuing theory [2-6].

Basically, queuing theory reduces waiting time to the minimum, eliminating traffics caused by queues, and minimizing costs caused by waiting. The queuing theory is used in the calculation of the queues created by the voyages passing through the straits, the prevention of the bottlenecks during loading and unloading in ports and in the planning of port operations. The purpose of this study is to demonstrate the use and benefits of queuing theory in marine transportation.

Keywords: Maritime, queuing theory, shipping, transportation, port.

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Control of Thermal Stresses Based on Angular Symmetric Fractional Heat Conduction Equation in A Half-Space

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Abstract

The generalized theories of thermoelasticity are based on fractional heat conduction equation which has emerged from the time-nonlocal dependences between the heat flux vector and the temperature gradient with the long-tale power kernel interpreted in terms of fractional calculus [1-3]. The fundamental solutions for fractional heat conduction equations in different coordinate systems and also the resulting thermal structures have been analyzed [4]. In the classical theory of thermoelasticity, some types of temperature control problems have been studied [5]. In the recent years, temperature control function has been analyzed as a source term or boundary value for a fractional heat conduction problem [6,7]

In this study, the time-fractional heat conduction equation with Caputo derivative of order $0 \le \alpha \le 2$ in a semi-infinite cylinder is considered. A sought-for function is used as a control which guarantees the fulfillment of restrictions on the thermal stress components. The temperature function is computed by applying the Laplace transform with respect to time t and the Hankel transform with respect to the angular coordinate r. Note that angular symmetric case is assumed throughout the formulation. By using the inverse integral transforms and also the conventional relation between temperature and thermal displacement functions, the control function is obtained. Consequently, the dependence of control function, the resulting displacements and stresses components on the variation of fractional order are evaluated.

Keywords: fractional heat-conduction equation, fractional thermoelasticity, control of thermal stresses

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Numerical Investigation of the Wrap Angle Effect on Swirler Blade Combustion Performance

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Abstract

Combustion chambers are one of the important components of gas turbine engines. The pressurized air with the compressor is mixed with the fuel in the combustion chamber and combustion reaction takes place. One of the expectations in combustion chamber design is that dynamic flow stability is maintained for every operating condition [1]. In order to provide this condition, fuel and energized air must be mixed homogeneously. In combustion chambers, swirler profiles are used to provide a more homogeneous mixture of fuel and air.

In this study, the effects of the wrap angle of the swirler blades on the combustion are examined using reacting turbulent Navier-Stokes equations. The reference swirler has 10 blades with a wrap angle of 45 degrees [2]. The combustion chamber has 6 dilution entrances. In this study, various swirler blade forms with 30, 45, 60, 75, 90 and 120 degrees of wrap angles are created. The number of blades, blade inlet and exit angles, blade inlet and exit widths, and blade thicknesses are kept constant to examine the effect of wrap angles. Once the swirler blade geometries are created, the flow volumes and suitable mesh structure are created for numerical analysis. In numerical analysis, k-ε turbulence model and standard wall functions are used. For the current flow problem, non-premixed combustion, energy, momentum and continuity equations are solved using the ANSYS Fluent flow solver. For the solution of these second order, nonlinear, partial differential equations; mass flow rate is defined at the air inlet, fuel inlet and dilution entrances and pressure are defined for combustion chamber outlet. Preliminary analysis shows that there exists an optimum wrap angle fort he defines mass and fuel flow rates.

Keywords: Combustion chamber, non-premixed combustion, swirler, wrap angle, CFD

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Initial-Boundary Value Problems in a Half-Space for an Advection-Diffusion Equation with Atangana-Baleanu Derivative

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Abstract

In the last decade, the generalized diffusive transports have been successfully modelled with fractional order derivatives such as Riemann-Liouville and Caputo [1,2]. Note that both of these derivatives are defined by exponential decay function as the kernel in their definitions given by improper integral. Because of this singularity problem, analytical solutions of the fractional order models in terms of conventional fractional derivatives are hardly available and hence increasing number of numerical methods has been proposed [3].

To remove the computational hardness of singularity arising from existing fractional derivatives, Caputo and Fabrizio firstly suggested a new operator with fractional order which is described by the exponential decay function as a non-singular kernel [4]. This non-singular operator is able to describe material heterogeneities and structures with different scales. After that, Atangana and Baleanu introduced new fractional derivatives in sense of Caputo and Riemann-Liouville by using the Mittag-Leffler function [5]. It can be seen in the literature that the non-singularity of these new operators allow better description of the memory effect in structures with different scales.

In the present study, an advection-diffusion equation in terms of Atangana-Baleanu derivative is considered in a half-space. Some initial and boundary value problems are defined and aimed to find the fundamental solutions of the relevant problems. For this purpose, Laplace and Fourier integral transform techniques are applied. Consequently, one- and two- parameter Mittag-Leffler solutions are obtained. It is worth to notice that the results are really closed to the existing formulation of fractional advection-diffusion equation in Caputo sense [6]. Finally, the solutions are concluded by the graphics.

Keywords: Atangana-Baleanu derivative, fractional advection-diffusion, Mittag-Leffler function, integral transforms

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Development of a 6-DoF Pose Estimation Package in ROS

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Abstract

Estimating the pose in 6 Degrees of Freedom (DoF) is crucial for vehicles that can navigate in 3D environments, like aerial or underwater vehicles. Robot Operating System (ROS) is a middleware platform for robot operations, such as control, navigation, and various guidance missions. ROS includes many pose estimation packages for ground vehicles, however these are not appropriate for aerial platforms. Available estimation packages work well in providing the 3-DoF pose for 2D planar motion for ground vehicles. Thus, ETH Zurich Autonomous System Lab developed Micro Aerial Vehicle (MAV) simulator, named as RotorS in order to test and integrate multicopter pose estimation within ROS environment [1]. The RotorS simulator do not include pose estimation using sensory information, but the modular configuration of the simulator enables us to add new features for calibration and verification purposes. This paper mainly discusses a novel 6-DoF pose estimation package and provides validation considering flight mechanical model of multirotor system using ROS integrated Gazebo environment within RotorS. We elaborate sensor simulation and contribute the capability of RotorS with the additional sensory package. The 6-DoF pose estimation is achieved using the hexarotor's on-board sensors including downward-pointing camera, Microsoft Kinect camera, 2D full spectrum LIDAR, 9-DoF Inertial Measurement Unit (IMU) and air pressure sensor. Gaussian noise is added on top of all sensor data for better visualizing the real world effects during the flight of hexarotor platform in a scenario map as illustrated in Figure 1. Techniques like scanmatch odometry [2] and visual odometry [3] are fused with simulated IMU and pressure sensor data using a Unscented Kalman Filter (UKF) to achieve an accurate localization. The localization can also be integrated with mapping and navigation missions for indoor environments. The developed pose estimation package is also offered as open source for further research activities.

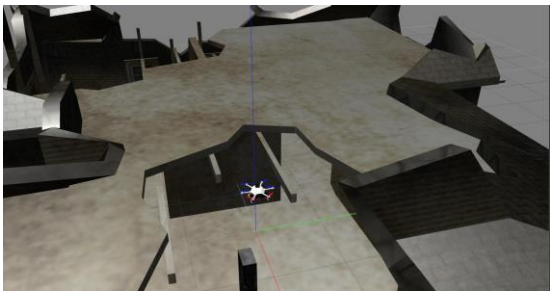

Figure 2: Pose Estimation of Hexarotor in Gazebo.

Keywords: Multicopter, Multi-Physical Simulation, ROS, Gazebo, Pose Estimation, Odometry, UKF

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SLAM based Control and Waypoint Navigation of Hexarotor Platform

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Abstract

Controlling the position, velocity, rate and attitude of an aerial vehicle requires well-tuned controllers. For this purpose, generally linear controllers, such as Proportional Integral Derivative (PID) or Linear Quadratic Regulator (LQR) are used. This paper presents the combination of waypoint navigation with Simultaneous Localization and Mapping (SLAM) and an implementation of an emerging nonlinear controller [1] on the hexarotor platform via Robot Operating System (ROS)/Gazebo environment. The aforementioned nonlinear controller is capable of stabilizing three motion modes including position, velocity, and attitude. The control system can switch in between these motion modes up to the mission requirements. This paper discusses only the implementation of position controller which is validated via RotorS simulation framework over ROS/Gazebo environment integrated with SLAM and waypoint navigation [2]. The main contribution of this study is the integration of the SLAM algorithm within RotorS. Finally, the aerial vehicle collects the image and LIDAR scan data to generate 2D and 3D maps of the simulated world in ROS/Gazebo environment as illustrated in Figure 1. If the waypoints are correctly given, the vehicle is able to fully map the targeted area and return to its initial position with errors less than %5 in a 30 meter run, while using the on-board sensory information for localization. For 2D mapping purposes the laser scan data from a 2D full spectrum LIDAR is used. 3D mapping is achieved by using the depth registered images and point cloud data generated from a simulated Microsoft Kinect camera [3]. An indoor scene is created in Gazebo environment and integrated with RotorS simulator on a hexarotor vehicle in order to verify the performance of SLAM algorithm.

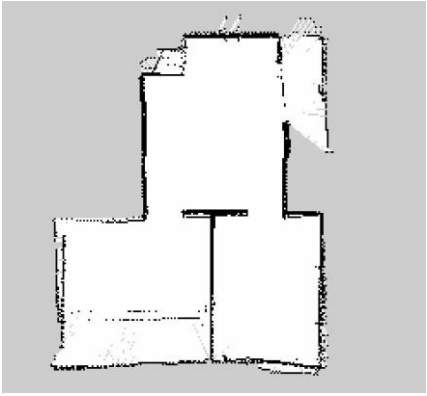

Figure 3: Generated 2D map of the scene.

Keywords: Multicopter, multi-physical simulation, ROS, gazebo, SLAM, control, navigation.

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An Analytical Approach to Solve Blasius Equation by Method of Weighted Residuals

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Abstract

Flows with high Reynolds number is so common in nature that it is essential to understand the physics behind it. Thus, the theory of fluid dynamics has been a very wide and important engineering field since 18th century. Today, some exact solutions for full Navier - Stokes equation are available, however all of them are only true for some limited cases. The difficulty of the problem is due to the multi-dimensional feature and non-linearity of the equations.

Despite the availability of all computation power provided by computers today, it is almost impossible to solve most of the three dimensional turbulent flows by direct numerical simulations. One effective tool to mathematically model such flows is the theory of boundary layers. Additionally an essential boundary layer problem is known as Blasius Flow and it is governed by an ordinary differential equation. Altough Blasius equation is much simpler when it is compared to the full Navier-Stokes Equation, no exact solution has been found yet.

In this study, well-known Blasius Equation is studied and an analitical solution approach is introduced. In order to obtain a highly accurate result which is valid for whole domain, a reliable method of weighted residual approach, namely Galerkin's Method is used. Two different trial functions both of which satisfies all boundary conditions are used in order to understand the effect of trial function selection. Additionally eigenfunctions of simpler problems are used as weight functions. Highly accurate results are obtained for whole domain by both trial functions which indicates that the methods of weighted residuals are practical tools for boundary layer problems.

Keywords: Blasius Equation, boundary layer flows, method of weighted residuals, Galerkin's method.

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Examples and Assessments for Pareto-Based Multi-Objective Optimization Approaches Used for Stand-Alone Hybrid Renewable Energy Systems

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Abstract

Optimization problems are classified as single-objective and multi-objective optimization problems depending on the number of objective functions to be solved. The approaches applied for solving multi-objective optimization problems are evaluated in terms of being able to complete the solution at acceptable time and to obtain solutions that are close to optimum when the problem size increases the Pareto-based multi-objective optimization approach is more advantageous. [1]. Optimization of stand-alone hybrid renewable energy systems (SA-HRES), which refers to the co-use of multiple renewable energy sources in distant regions from the grid, is an important real-life problem falling into the category of multi-objective and very limited optimization problems. It is almost impossible to obtain real optimum in solving these problems, as the number of renewable energy sources included in SA-HRES and the number of objective functions such as dimension optimization and system reliability increase. Therefore, among the meta-heuristic methods which can obtain the solutions closest to the optimum, the methods including the Pareto-optimum solution approach produce more realistic results in terms of optimizing the conflicting objective functions of the problem. In this study, multi-objective optimization of SA-HRES were evaluated through examples in order to demonstrate the effectiveness of Pareto-based multi-objective optimization approaches.

Keywords: Multi-objective optimization, Pareto-optimum, stand-alone hybrid renewable energy systems.

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Extended Exp (-φ (ξ)) Expansion Method for Some Exact Solutions of Sixth-Order Ramani Equation and Coupled Modified KdV-type Equation

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Abstract

Nonlinear partial differential equations (NPDEs) have an important place in applied mathematics and physics [1,2]. Many analytical methods have been found in literature [3]. Besides these methods, there are many methods which reach to solution by using an auxiliary equation. Using these methods, partial differential equations are transformed into ordinary differential equations. These nonlinear partial differential equations are solved with the help of ordinary differential equations. In this paper, we implemented extended exp (-φ (ξ)) expansion method [4] for some exact solutions of sixth-order Ramani equation and coupled modified KdV-type equation.

Keywords: Extended exp (-φ (ξ)) expansion method, Sixth-order Ramani equation, Coupled modified KdV-type equation, exact solutions

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Wind Energy Investments' Profitability Index Based on Artificial Neural Networks

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Abstract

Wind power is the most common, widely applicable and productive renewable energy source. Studies about energy investments, wind speed predictions and renewable energy systems application with neural networks have been investigated especially about for a quarter century. In this study it is aimed to predict the wind energy products and investment value with a multilayer neural network approach. For this aim a feed-forward back propagation neural network model has been established. As a set of data, wind speed values of 48 months (January 2012-December 2016) have been used. The data is obtained from actual investment project. The training data set occurs from 36 monthly wind speed values (January 2012-December 2015) and the test data set occurs from rest of the values (January-December 2016). The results obtained suggest that the ANN model can be used quite successfully in this area and it can predict correctly the value of wind power with an accuracy margin error even for unknown samples. The training of the ANN is performed by using Microsoft Visual Studio C#.NET 2013.

Keywords: wind power prediction, artificial neural network, wind energy investment

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Optimization of Capacitance and Speed Values for Self-Excited Induction Generators using the Response Surface Method

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Abstract

Over the past few decades, there has been a considerable use of renewable energy sources because of the growth in energy demand and environmental hazards of uncurbed emissions. Wind energy technology, with an induction generator in stand-alone mode, has been playing a big role over other renewable technologies because of its low cost, wide speed operation range, brushless structure, and low maintenance [1]. Utilization of self-excited induction generators (SEIGs) is becoming more popular among wind energy technologies in rural areas. Besides its simplicity and robustness, it requires an external reactive source, which is commonly a balanced capacitor bank connected to its stator windings [2]. Despite the above advantages, the major drawback of this type of generator is its poor voltage and frequency regulation that primarily depends on the generator speed, load impedance, excitation capacitance and magnetizing reactance [3].

In this paper, the Response Surface Method (RSM) is applied in order to determine the optimal steady-state performance for the SIEG instead of the commonly used nodal admittance method or the loop impedance technique [4]. The main objective of the proposed approach is to determine the excitation capacitance and shaft speed to maintain a constant terminal voltage magnitude and frequency of the SEIG at the desired level for different load conditions. Consequently, a response surface model is constructed in which the capacitance value and the shaft speed are considered the inputs, whereas the voltage magnitude and frequency are assumed to be the outputs. The simulation results demonstrate the effectiveness of the method proposed in this paper since the regression value R^2 obtained was 99.98%. In particular, for a 4 kW squirrel cage induction generator with a 950.8 Ohm resistive load per phase, the excitation capacitance and shaft speed were found to be 68.9 µF and 1504 rpm respectively. Moreover, the output voltage magnitude and frequency obtained were 230.2 V and 50 Hz respectively.

Keywords: SEIG, response surface method (RSM), wind energy, constant voltage and frequency.

Acknowledgements

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Adaptive Fuzzy Sliding Mode Control Based LMIs of MIMO Nonlinear Uncertain Systems

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Abstract

In practical control engineering, fuzzy system-based adaptive control methodologies have received much attention, emerging as promising approaches for controlling highly uncertain and nonlinear dynamical systems. Most of complex dynamic systems include nonlinearities and uncertainties which are difficult to define with mathematical model. Fuzzy Logic has been widely applied to the many complex dynamic systems. When mathematical models are unknown or partially unknown, fuzzy control models can used fuzzy systems to estimate the unknown models. Sliding Mode Control has been used as a robust technique for its insensitivity to external disturbances and model uncertainties. The SMC are preferred in industrial application because of fast response, good transient performance and order reduction. Adaptive control methods have successfully exhibited in tracking control applications for uncertain nonlinear system. The integration of the Fuzzy Logic and Sliding Mode based on adaptive schemes has provided the contributions in order to maintain the desired performance of the system according to uncertainties and variations of the plant parameters. Therefore, this paper presents two indirect adaptive fuzzy control schemes for a class of uncertain continuous-time multi-input multi-output nonlinear dynamic systems. Within these schemes, fuzzy systems are employed to approximate the plant's unknown nonlinear functions and robustifying control terms are used to compensate for approximation errors. By using a regularized matrix inverse, a stable well-defined adaptive controller is firstly investigated. Then, in order to obtain an adaptive controller not depending upon any parameter initialization conditions and to relax the requirement of bounding parameter values, a second adaptive controller is proposed. All parameter of the adaptive laws and robustifying control terms are derived based on Lyapunov stability analysis so that, under appropriate assumptions, semi-global stability and asymptotic convergence to zero of tracking errors can be guaranteed. These simulation results demonstrate the tracking capability of the proposed hybrid control system and its effectiveness for the control tracking of uncertain nonlinear systems.

Keywords: Sliding mode control; fuzzy adaptive control; MIMO nonlinear systems; linearization feedback; Lyapunov function.

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Global Stability of Latent Chikungunya Virus Dynamics Model with Multitarget Cells and Saturation

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Abstract

Chikungunya virus (CHIKV) is an alphavirus and is transmitted to humans by Aedes aegypti and Aedes albopictus mosquitoes. The CHIKV attacks the target cells and causes Chikungunya fever with symptoms such as rashes, chills and fever. Symptoms usually occur after an incubation period of 4-7 days. CHIKV has been an outbreak in the last decade in some parts of the world and has increased the population of people at risk [1]. Although CHIKV pathogenesis in humans is not yet completely understood, but recent outbreaks have provided deep understanding into the organs and cells involved in the viral replication.

CHIKV infects and replicates in a variety of cells, such as fibroblasts, macrophages, monocytes, skeletal muscle satellite cells and other skin cells [2]. In the literature of CHIKV infection, most of the mathematical models presented described the disease transmission in mosquito and human populations [3-6]. This paper proposes a latent Chikungunya viral infection model with multitarget cells. The model incorporates (i) two types of infected cells, latently infected cells and actively infected cells which produce the CHIKV particles (ii) saturated incidence rate which is suitable to model the nonlinear dynamics of the CHIKV especially when its concentration is high (iii) antibody immune response. We derive biological threshold number R0 for the model. Using the method of Lyapunov function, we established the global stability of the steady states of the model. The theoretical results are confirmed by numerical simulations.

Keywords: Global stability; Chikungunya virus infection; Target cells; Lyapunov function

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Caputo's Fractional Derivative Model of Immune Response to Tumor Growth

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Abstract

The mathematical models are used to understand for complex statement. One of the complex statement is immune response to tumor growth. Tumor growth is directly influenced by immune system's cell. For example, CD8+ T cells are components of immune system which kill tumor cells. So, we study interaction between tumor growth and immune system model in this paper. The model involves tumor cells, helper CD4+ T cells, CD8+ cytotoxic T cells, dendritic cells (DC) and cytokine interleukin-2 (IL-2). The model is presented by F. Castiglione and B. Piccoli [1].

We give a detailed stability analysis of treatment free and fixed points. We explain that the quantity of tumor and tumor growth by using a Caputo's fractional derivative. Caputo's fractional derivative model will be solved by Grünwald-Letnikov method.

Keywords: Immune response to tumor growth, dendritic cells (DC), cytokine interleukin-2 (IL-2)

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Effect of Discrete Time Delay and Antibodies on HCV Dynamics with Cure Rate and Two Routes of Infection

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Abstract

Mathematical modeling and analysis of viral infection models have attracted the interest of several researchers during the last decades. These works can help researchers for better understanding the viral dynamical behavior and providing new suggestions for clinical treatment. The basic viral infection model presented in [1] has focused on modeling the interaction between three main compartments, uninfected cells, infected cells and free virus particles. Hepatitis C virus is considered one of the dangerous human viruses that infects the liver and causes the lever cirrhosis. The "cure" of infected cells has been considered in the virus dynamics models in several works [24]. In [41], both cure and cell-to-cell transmission have been considered in the virus dynamics model, but without taking the immune response into account. In this paper we propose and analyze an HCV dynamics model taking into consideration the cure of infected hepatocytes and antibody immune response. We incorporate both virus-to-cell and cell-to-cell transmissions into the model. We incorporate a discrete-time delay to describe the time between the HCV or infected cell contacts an uninfected hepatocyte and the emission of new active HCV. We show that the solutions of the proposed model are nonnegative and ultimately bounded. We derive two threshold parameters which fully determine the existence and stability of the three steady states of the model. Using Lyapunov functionals, we established the global stability of the steady states of the model. The theoretical results are confirmed by numerical simulations.

Keywords: Hepatitis C virus, global stability, time delay.

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A Contact Problem for a Half-space With Inhomogeneous Coating

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Abstract

We address an elasticity problem on an inhomogeneous half-space. The contact problem in case of shearing deformation is studied. The contact problem under the assumption that is perfectly bonded to both the coating width H and substrate is defined. Here, it is aimed to present the generalization of the N-punches. The punches with flat bases are in contact with the elastic inhomogeneous coating along $y=0,\ x \in w=\bigcup_{i=1}^{N}(a_i,b_i)$, where $(a_i,b_i) \cap (a_j,b_j)=\varnothing$, $i,j=1,2,\ldots,N$. The punches are subjected to forces P_i, $i=1,2,\ldots,N$, which are parallel to axis z and outside of the punches the surface is traction-free. So, state of plane strain and the changing of the shear modulus (G) with respect to depth in the range $[-H, 0]$ are considered. Also, when ($| x |; - y$) $\rightarrow +\infty$, the stresses vanish. The continuity conditions on layer substrate interface are given. The basic equations of the elasticity theory are presented. Displacements and stresses are conjugated by Hooke's law. By using the basics of the elasticity theory and using the Fourier transform of the displacement, the problem is reduced to a system of ordinary differential equation. Solving the system of ordinary differential equations and considering the Fourier transform of contact pressures leads to a system of integral equations. By changing the order of integration and making the change of variables, the obtained system of integral equations are converted into dimensionless form. So, the construction of kernels of integral equations in the case of $G=G_0e^{vy}$, where v is the nonhomogeneity parameter controlling the variation of the shear modulus in the coating medium, is performed. Finally, the appropriate approximate solution is presented.

Keywords: Contact problems, elasticity theory, integral equations.

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A Second Order Numerical Technique for Multi Term Variable Order Fractional Equations

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Abstract

In this work, a second order convergent method is studied for variable order fractional differential equations. Ordinary derivative terms, together with the unknown function, are also added to the single term differential equation and tested for convergence. Here, we approximate the varying Riemann-Liouville derivative with the second-order convergent method (see reference [1]) and this method is based on the shifted Grünwald approximation and ordinary derivatives are discretized by finite difference scheme. The resulting numerical scheme is still second-order convergent. Additionally, some comparisons have also been made with other numerical techniques for the non-variable order fractional derivative (see references [2-4]).

Keywords: Fractional ordinary differential equations, Riemann Liouville derivative, finite difference scheme.

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This work is part of a master's thesis produced under my supervision.

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Oscillation Theorems for Second Order Half-Linear Mixed Neutral Differential Equations

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Abstract

In this study, we shall offer sufficient conditions for the oscillation of all solutions to second-order half-linear neutral differential equations of mixed type. The results presented here do not need several restrictive assumptions required in related results in the literature and can easily be extended to more general neutral differential equations as well as to neutral dynamic equations on time scales. We also give some examples to show the importance of our results.

Keywords: Oscillation, second-order, neutral differential equations

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New Oscillation Criteria for Second Order Nonlinear Neutral Differential Equations with Damping Term

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Abstract

In this talk, we discuss the oscillatory behavior of solutions to a class of the second order damped nonlinear neutral differential equations. Some new oscillation results are obtained that improve and extend a number of related results reported in the literature. Examples are also provided to illustrate the theorems.

Keywords: Oscillation, second order, neutral, damping term

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Philos-Type Oscillation Criteria for Second Order Half-Linear Mixed Neutral Differential Equations

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Abstract

In this work, Philos-type oscillation criteria for second-order half-linear mixed neutral differential equations are established. The results obtained essentially improve and extend some known results in the literature. Examples are also provided to illustrate the applicability of the results.

Keywords: Oscillation, second-order, neutral differential equations

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Conformable Operator in Approximate Solutions of Nonlinear Differential Equations

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Abstract

In this study, we consider some linear/nonlinear fractional differential equations (FDEs) containing conformable derivative operator. We obtain approximate solutions of these mentioned FDEs in the form of infinite series which converges rapidly to its exact value by using modified homotopy perturbation method (MHPM) and homotopy analysis method (HAM). Using the conformable operator in solutions of different types of FDEs makes the solution steps are computable easily. Especially, conformable operator has been used in modelling the FDEs and describing certain problems such as engineering, material sciences, economic and other areas of application. In this context, the aim of this study is to solve some illustrative linear/nonlinear problems as mathematically and to compare the exact solutions with the obtained solutions by considering some plots. Moreover, it is an aim to show the reliability and simplicity of the methods constructed with the conformable operator.

Keywords: Approximate solution, nonlinear differential equations, conformable operator, homotopy analysis method, modified homotopy perturbation method.

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Fractional Calculus: Some Hidden Aspects

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Abstract

Fractional calculus is in fact the calculus of integration and differentiation of arbitrary order (see for example [1-13]) and it was applied successfully to complicated problems from various fields of science and engineering. In my talk I will present some hidden aspects of the fractional calculus. Several illustrative examples of real world applications will be presented to validate the theoretical results.

Keywords: Fractional calculus, Caputo derivative, Mittag-Leffler non-singular kernel.

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A Compact Integrated THz Horn-shaped Helix Antenna based on MEMS Technology using Accurate Automatic Strategists

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Abstract

Artificial Neural Networks (ANN) present a relevant class of accurate automatic strategists leading to novel models and optimal solutions in the field of radiofrequency (RF) engineering. Micro-electromechanical system (MEMS) antennas, have achieved over the past decade interesting characteristics after having employed such a kind of automated data training process having the ability to capture multi-dimensional arbitrary nonlinear relationships in a very fast way to offer fitness functions for excellent bandwidth learning and fast configuration evaluating. Interestingly, this research study describes how ANNs are employed to calculate the resonant frequencies and return losses and provide a high level of accuracy and performance when developing a compact integrated horn-shaped helix antenna employing silicon substrate with terahertz (THz) waves.

Keywords: RF engineering, automated data training, ANNs, helix antennas, MEMS, THz waves.

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A Highly Miniaturized MEMS Pyramidal Helix Antenna for THz Applications using Reliable Evolutionary Optimizers

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Abstract

Evolutionary optimizers comprising Sequential Nonlinear Programming (SNLP) Algorithms lead to excellent solutions to retain a good accuracy as compared with finite element modeling (FEM) to develop new design models of highly miniaturized terahertz (THz) antennas based on micro-electromechanical system (MEMS) technology. This research work explains SNLP method has been efficiently applied in modeling a compact MEMS pyramidal helix antenna due to the fast progress of computer aided design (CAD) tools which meet the very specific requirement of such compact antennas to achieve a high geometrical accuracy and provide a high performance for the selective band of frequencies.

Keywords: Evolutionary optimizers, sequential nonlinear programming, helical antennas, micro-electromechanical system technology, terahertz band.

Acknowledgements

This work is supported by the Laboratory of Telecommunications at Abou Bekr Belkaid University of Tlemcen, Algeria under the doctoral research program: Computational Electromagnetic Characterization of Complex THz Antennas based on MEMS Technology.

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Framework for Analysing of Inter-cluster Communication in the DRHT by using Game Theory

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Abstract

The system performance of the delay tolerant networks (DTN) can be significantly improved by using a topology called DTN routing hierarchical topology (DRHT) which incorporates three fundamental concepts: ferries messages, ferries routes and clusters. The intra-cluster routing is managed by the cluster head, while the inter-cluster routing is managed by the ferries messages. In this paper, we analysis and study the behavior of data dissemination problem of ferries in the DRHT. More specifically, we formulate a non-cooperative game and game stochastic modeling the behavior of the ferries for analyzing of the inter-cluster communication in the DRHT.

Keywords: Delay Tolerant Networks (DTN), DRHT, Game theory, Nash equilibrium, Game stochastic.

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New numerical approximation of fractional derivative with non-local and non-singular kernel: Application to chaotic models

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Abstract

Recently a new concept of fractional differentiation with non-local and non-singular kernel was introduced in order to extend the limitations of the conventional Riemann-Liouville and Caputo fractional derivatives. A new numerical scheme has been developed, in this paper, for the newly established fractional differentiation. We present in general the error analysis. The new numerical scheme was applied to solve linear and non-linear fractional differential equations. We do not need a predictor-corrector to have an efficient algorithm, in this method. The comparison of approximate and exact solutions leaves no doubt believing that, the new numerical scheme is very efficient and converges toward exact solution very rapidly.

Keywords: non-singular kernel, new numerical scheme, Atangana-Baleanu derivative.

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On the Co-PI Energy of Graphs

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Abstract

Let G be a finite, connected, simple graph. The Co-PI eigenvalues of a connected graph G are the eigenvalues of its Co-PI matrix. The largest Co-PI eigenvalue is called the Co-PI spectral radius of G. The Co-PI energy of a graph is defined as the sum of the absolute values of Co-PI eigenvalues of G. In this study, we present some bounds for the Co-PI energy and Co-PI Spectral Radius; and characterise those graphs for which these bounds are the best possible.

Keywords: Graph Theory, Co-PI energy, Co-PI index

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The Number of Spanning Trees of Graphs

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Abstract

For a given a simple connected graph, we present some new bounds via a new approach for the number of spanning trees. Useage this approach presents an advantage not only to derive old and new bounds on this topic but also gives an idea how some previous results in similar area can be developed.

Keywords: Spanning trees; normalized Laplacian eigenvalues; (degree) Kirchhoff index; Randic index

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SIR Epidemic Model with Caputo-Fabrizio Fractional Operator

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Abstract

Mathematical modelling of infectious diseases has shown that combinations of isolation, quarantine, vaccine and treatment are often necessary in order to eliminate most infectious diseases. Continuous mathematical models have been used to study the dynamic of infectious diseases within a human host and in the population. We have used in this study SIR model which categorises individuals in a population as Susceptible (S), Infected (I) and Recovered (R). It also simulates the transmission dynamics of diseases where individuals acquire permanent immunity. We have considered the SIR model using the Caputo-Fabrizio-Caputo sense and we have obtained special solutions and numerical simulations using an iterative scheme with Laplace transform. Moreover, we have studied uniqueness and existence of the solutions.

Keywords: SIR epidemic model, Caputo-Fabrizio fractional operator, Mathematical modelling

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New Analytical Solutions of (3+1) Extended Jimbo Miwa Equation

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Abstract

In this paper, we are going to apply a new method, which is proposed by Khater *et al*., named as extended modified Exp$\left(-\Omega(\xi)\right)$ for obtaining analytical solution of the (3+1) extended Jimbo Miwa equation. The analytical technique considered in this paper provides a rich number of trig, hyperbolic, and rational types solutions, to be found. In the first chapter, we are going to introduce the method and handled equations. As we progress, we are going to apply the method to aforementioned equation. This application results in a series of algebraic equation system. With the aid of symbolic computation, after solving the newly obtained system, new analytical solution of the equation can also be constructed. The newly obtained results by the extended modified Exp$\left(-\Omega(\xi)\right)$ method indicate that the method is a powerfull, efficient and attractive technique for solving partial differential equations.

Keywords: Extended modified Exp$\left(-\Omega(\xi)\right)$ method, extended Jimbo Miwa equation, analytical solutions

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Numerical Solutions of Time Fractional Burgers'- Equation using Finite Difference Methods

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Abstract

In this study, one dimensional time fractional Burgers' equation having time derivative in terms of Caputo sense has been solved using finite difference methods. Several test problems together with different set of initial and boundary conditions have been solved to test the efficiency and accuracy of the present method. The error norms L_2 and L_∞ have been computed and compared with some of those in the literature. The results found in the study have been presented in tables and graphics.

Keywords: Finite Difference Methods, Burgers' equation, Caputo fractional derivative

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Calibration of a Hydrological Model by Using a Hybrid Approach Combining Levenberg-Marquardt and Particle Swarm Algorithms

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Abstract

Conceptual hydrological models are broadly implemented by hydrologists and water resources engineers as an indispensable instrument to make out and direct dynamical activities that affect river flows, dam reservoirs, operational strategies of hydraulic structures, and so on. The accomplishment of these models rests on how well they are constructed. Accordingly, their parameters controlling hydrological processes need to be calibrated by an optimization algorithm so that measured and predicted flow values are in balance. Before the prevalent existence of evolutionary optimization algorithms like genetic algorithms and particle swarm optimization, the researchers were used to adjusting the model parameters through some conventional methods (e.g., Quasi-Newton and Levenberg-Marquardt), in which approximate derivatives were calculated by finite differences. Although they are powerful in speeding up the convergence, they may suffer the issue of local minimum trap. On the other hand, as evolutionary optimization algorithms that pass over local minimum troubles, are mainly stochastic, there is no warrant that different runs under the same circumstances can find the same solutions. Moreover, the use of a large number of operators in evolutionary algorithms can reduce the convergence of the problem. In the study prepared on the basis of the above grounds, a hybrid algorithm which is not only affected by the local minima process but also has strong convergence ability has been proposed in order to calibrate a five-parameter conceptual hydrological model termed as dynamic water budget model. This hybrid technique basically consists of the combination of Levenberg-Marquardt (LM) and particle swarm optimization (PSO) algorithms. Results derived from fifty independent runs have revealed that the hybrid approach is quite successful compared to the singular PSO. As a result of several examinations, the outputs generated by hydrological model calibrated through developed method have matched satisfactorily with the flow measurements.

Keywords: Conceptual hydrological model, Levenberg-Marquardt, particle swarm optimization, hybrid algorithm

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Numerical Computation of the Mittag-Leffler Function

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Abstract

The Mittag-Leffler function (MLF) is ubiquitous both in the theory of fractional calculus and its applications [1, 2]. In fact, the impulse response of fractional linear systems can be expressed in terms of the MLF, which entails the need for efficient algorithms devoted to its computation. However, this calculation is not trivial, except when considering small values of the argument, since the numerical computation of the MLF poses problems of both accuracy and convergence [2-4].

In this paper we tackle this problem. We start from the general integral formula for the 2-parameter MLF and we develop a method for its numerical implementation. We then particularize the general formulation for values on half-straight lines, which are useful in its application to linear systems. In a second step, we introduce a generalization of the MLF and we propose one method based on the efficient computation of the inverse Laplace transform. We adopt the bilinear transformation to follow a Z-transform form and use the fast Fourier transform to obtain a sampled version of the generalized MLF. Finally, based on these ideas, we consider also the implementation of the 3-parameter generalized MLF.

Keywords: Mittag-Leffler function, numerical computation, fast Fourier transform.

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Application of Artificial Bee Colony Algorithm for Distance Restricted Vehicle Routing Problem

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Abstract

The artificial bee colony (ABC) algorithm is an optimization algorithm based on the behavior of honey bees in order to achieve their nutrient specific behaviors [1]. In this study, it is aimed to visit all the towns of Balikesir (Turkey) with the vehicle used by the controllers of *Balikesir Directorate of Science, Industry and Technology* under the given constraints using the ABC algorithm. The aim was to minimize the pathway of the vehicle and to visit all the towns by the routes with a length of 550 km. In other words, the vehicle will return to the point where it starts from Balikesir province center on every turn and starts again without exceeding the 550 km limit. It is aimed to determine the optimum routes so that the total length of all routes is minimized and all of the 19 towns are visited exactly once. Routes used by provincial directorate in current practice are: [City Center (1) – Savastepe (2) – Bigadic (3) – Sindirgi (4) – City Center (1)], [City Center (1) – Kepsut (5) – Dursunbey (6) – City Center (1)], [City Center (1) – Susurluk (7) – Manyas (8) – Gonen (9) – City Center (1)], [City Center (1) – Bandirma (10) – Erdek (11) – Marmara Island (12) – City Center], [City Center (1) – Balya (13) – Ivrindi (14) – Havran (15) – Edremit (16) – City Center (1)], [City Center (1) – Burhaniye (17) – Gomec (18) – Ayvalik (19) – City Center (19)] and the total length of the routes is 1452 km. In order to solve the problem, 10 onlooker bees and 10 employed bees are used. The parameters of the algorithm are determined as: the number of food is 100, the distance limit is 550 km, the number of towns is 19, and limit was 100. The algorithm is coded on MATLAB and run for 10000 iterations. Optimum length of the routes is calculated as 1031 km. This total length is composed of 4 routes each of which are less than 550 km. These routes are: [City Center (1) – Edremit (16) – Gomec (18) – Ayvalik (19) – Burhaniye (17) – Havran (15) – City Center (1)], [City Center (1) – Savastepe (2) – City Center (1)], [City Center (1) – Ivrindi (14) – Balya (13) – Gonen (9) – Marmara Island (12) – Erdek (11) – Bandirma (10) – Manyas (8) – Susurluk (7) – City Center (1)], [City Center (1) – Kepsut (5) – Dursunbey (6) – Bigadic (3) – Sindirgi (4) – City Center (1)]. The results indicate that by using the ABC algorithm, the total length of the vehicle is reduced by 421 km and 29% improvement is achieved. That means the ABC algorithm can be used effectively to solve the distance restricted vehicle routing problems. In future work; the problem solution will be expanded in such a way that the towns with population over 100.000 will be visited at least 3 times.

Keywords: Artificial bee colony algorithm, distance restricted vehicle routing problems, optimization

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Hyperbolic Function Solutions for Positive Gardner-KP Equation

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Abstract

In this paper, modified $\exp(-\Omega(\xi))$-expansion function method has been handled for finding exact solutions of positive Gardner-KP equation. Hyperbolic function solutions of positive Gardner-KP equation have been obtained by means of this method. Moreover, by the help of Mathematica 9, some graphical simulations were given to clarify the behavior of these solutions.

Keywords: Modified $\exp(-\Omega(\xi))$-expansion function method, positive Gardner-KP equation, hyperbolic function solutions.

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Calculation of the Mass Attenuation Coefficients, Effective Atomic Numbers and Effective Electron Numbers of Some Concrete Containing Pumice and Barite at Different Ratios

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Abstract

In this study, the total mass attenuation coefficients of concrete containing different proportions of barite and pumice as an aggregate have been measured at gamma energies of 511, 835 and 1275 keV. Also, the mass attenuation coefficients have been calculated at the photon energy range of 1 keV–1 GeV by using XCOM [1-2]. The effective atomic numbers (Zeff) and effective electron density (Ne) for concretes have been determined via the mass attenuation coefficients (μ/ρ) [3-4]. The obtained results for concretes containing pumice are compared with the results for concretes containing barite. According to this comparison, the calculation results obtained for the barite reinforced concrete are higher.

Keywords: Mass Attenuation Coefficient, Effective Atomic Number, Effective Electron Density

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Investigation of Lifetime Cancer Risk and Radiological Hazards in Some Marble Samples Mining from the Marmara Region

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Abstract

Living creatures have been under the influence of natural radioactivity due to long half-life radioactive nuclei in the earth's crust since the cosmos has existed. This natural radioactivity is caused by gamma radiation from uranium, thorium series and potassium [1]. For this reason, concentrations of 40K, 226Ra, 232Th were measured by gamma spectrometry system in order to determine the natural radioactivity levels of some marbles extracted from the Marmara Region and used as building materials in particular [2-3]. Absorbed gamma dose rate (D), annual effective dose equivalent (YEDE), radium equivalent activity (Raeq), internal hazard index (Hi) and external hazard index (Hd) values using the 40K, 226Ra, 232Th activity concentrations obtained as a result of the measurements It was calculated. In addition, lifetime cancer risk (LCR), which is a consequence of radiation exposure, has been calculated [4]. All the results obtained are compared with the limit values recommended by international organizations. According to these results, it can be concluded that there is no harm in terms of both radiological damage indices and dose parameters.

Keywords: Lifetime Cancer Risk, Radiological Hazards, Marble

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