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Preface

Engineering mathematics and physics are branches of applied mathematics and physics concerned with results, methods, and techniques used in engineering and industrial applications. Much of the research work produced by engineers may be taken to fall under the rubric of engineering mathematics and physics, provided that it passes some reasonable level of theoretical sophistication. Foundational research in the mathematical and physical underpinnings of engineering problems continues to be fascinating, deep, and indispensable.

This volume contains the papers presented at the International Conference on Recent Advances in Engineering Mathematics and Physics (RAEMP2019) organized by the Department of Engineering Mathematics and Physics at Cairo University which was held in Cairo, Egypt, in December 2019. The papers discuss some of the latest advances in the applications of mathematics and physics in different engineering disciplines including information technology, control, mechanical engineering, electromagnetic waves, and solid-state electronics. Contributions come from both academia and the industry.

All submissions were reviewed by two reviewers on average, with all reviewers affiliated to diverse reputable international institutes. Out of 65 papers which were submitted to the conference, 42 were selected by the program committee, while only 27 made it to the final conference proceedings.

We would like to express our sincere thanks to the plenary speakers, session chairs, and all reviewers for helping us produce a rich technical program. We would also like to extend our sincere appreciation for the outstanding work contributed over many months by the organizing committee.

Mohamed Hesham
Maha Hassanein

Editors

Mohamed Hesham Farouk, Prof. Engineering Mathematics and Physics Department, Chair, Faculty of Engineering, Cairo University

M. Hesham had his Ph.D. on 1994 on digital processing of speech and is now a full time professor at the Engineering Mathematics and Physics Department, Cairo University. He has a long experience in the field of engineering physics since 1990 when he participated as a research assistant in a research project funded by research agency at Egypt for upgrading the control system of Coke-calciner at EGYPALUM. Prof. Hesham also participated in another funded project on developing an intelligent Automatic Testing Equipment (ATE) for PCB during the mid-nineties. He has many publications in the field of acoustic scattering and wavelet-based machine-learning. He also, recently supervised theses on a related topic. He was the principal-investigator (P.I) of a funded research in the field of intelligent processing of instructional video in 2007. In 2017 he finalized, as a P.I., another funded project on electronic-circuits inspection using thermography. Prof. Hesham is the author and co-author of more than 30 papers and one-book published by Springer.

Maha Amin Hassanien, Prof. Engineering Mathematics and Physics Department, Chair, Faculty of Engineering, Cairo University

Maha A. Hassanein is a professor at the Department of Engineering Mathematics and Physics - Cairo University, Egypt (CUFE), where she has been a faculty member since 1989. Maha completed her PhD and M.Sc degrees in Engineering Mathematics in 1999 and 1994, respectively, and her B.Sc. degree in Communication and Electronic Engineering in 1989, all at CUFE. Her research interests lie in the area of numerical linear algebra, parallel computing on Graphics Processing Units (GPU), interval analysis and Wavelets theory. She is the author and co-author of 16 research papers related to her research interests. Maha is a college educator with years of experience teaching a variety of mathematics courses for engineering students. Maha has interests for the quality of education where she attended a variety of workshops for the quality assurance and accreditation (QAA) and has an ABET certificate in program assessment in 2019. She held a position at the QAA unit at CUFE from 2014 until 2017.

Abstracts of Invited Talks

Towards Man-Machine Symbiosis

A. H. Tewfik

Department of Electrical and Computer Engineering, University of Texas Austin

Numerous articles in the general press warn against a dark future in which evermore powerful machines will displace humans. Yet, empirical evidence establishes that properly designed human – machine systems outperform man and machine and have the potential of increasing human creativity and cognitive abilities. In this talk, I will provide an overview of cognitive biases in human decision-making, give examples of man-machine symbiosis and review our recent work in the area. In particular, I will focus on machine-assisted human decision making and the use of brain machine interfaces to improve speech recognition, recognize the audio source a person is listening to and whether the person is listening to her mother tongue. Time permitting, I will describe some of the work that we have been performing on reducing the amount of data needed to train support vector machines and deep neural networks.

Ahmed H Tewfik received his B.Sc. degree from Cairo University, Cairo Egypt, in 1982 and his M.Sc., E.E. and Sc.D. degrees from MIT, in 1984, 1985 and 1987 respectively. He is the Cockrell Family Regents Chair in Engineering and the Chairman of the Department of Electrical and Computer Engineering at the University of Texas Austin. He was the E. F. Johnson professor of Electronic Communications with the department of Electrical Engineering at the University of Minnesota until September 2010. Dr. Tewfik worked at Alphatech, Inc. and served as a consultant to several companies. From August 1997 to August 2001, he was the President and CEO of Cognicity, Inc., an entertainment marketing software tools publisher that he co-founded, on partial leave of absence from the University of Minnesota. His current research interests are in cognitive augmentation through man-machine symbiosis and mobile computing, low energy broadband communications, applied machine learning and brain computing interfaces. Prof. Tewfik is a Fellow of the IEEE. He was a Distinguished Lecturer of the IEEE Signal Processing Society in 1997 - 1999. He received the IEEE third Millennium award in 2000 and the IEEE Signal Processing Society Technical Achievement Award in 2017. He was elected to the positions of President-elect of the IEEE Signal Processing Society in 2017 and VP Technical Directions of that Society in 2009. He served as VP from 2010-2012 and on the board of governors of that Society from 2006 to 2008. He has given several plenary and keynote lectures at IEEE conferences.

http://www.ece.utexas.edu/people/faculty/ahmed-tewfik

Abstracts of Invited Talks

Frequency Selective Surfaces for mm Wave Antennas Gain Enhancement and Radar Scattering Control

Abdel Razik Sebak

Recently, there has been increasing interest and rapid growth in millimeter (mm)-wave antennas and devices for use in diverse applications, services and technologies such as short-range communication, future mm-wave mobile communication for the fifth generation (5G) cellular networks, and sensor and imaging systems. Due to the corresponding smaller wavelength, mm-wave frequencies offer the advantage of physically smaller antennas and circuits as well as the availability of much wider bandwidth compared to microwave frequencies. In addition they provide additional spectrum for wireless communications. The planned 5G cellular networks base stations and mobile devices will essentially make use of mm-wave frequency bands to meet consumers' ever growing demand for high data rate and capacity from wireless service providers.

Millimeter-wave antenna design is considered as the first step for realizing mm-wave wireless communication and imaging systems. Design requirements for such antennas include highly directional patterns – for long transmission range and high detection sensitivity - and size reduction with a suitable impedance matching bandwidth. Frequency selective surface (FSS) technology is recently employed to enhance the performance of radiation and scattering properties of antennas used in different sectors such as aerospace, medical, and microwave industry. Therefore, it is appropriate and attractive to propose the use of FSS technology to design practical and efficient high gain antennas. This talk will address the market demand for compact high efficient antennas for next generation wireless communications, sensing and imaging systems. The main part of the talk will focus on investigation and development of mm-wave high gain broadband antenna elements and arrays that cover multiple mm-wave frequency bands to serve several applications. Antennas with high gain produce very directive narrow beam for high resolution sensing as well as reduce the demand for power requirements and consumptions by wireless systems.

The talk will also discuss the development of frequency selective surface (FSS), and their diverse applications in millimeter-wave electromagnetic spectrum including: (a) an approach to enhance circularly-polarized (CP) antenna gain (b) a linear to circular polarization converter which is based on multilayer FSS slab, and (c) a wideband FSS metasurface for radar cross section (RCS) reduction based on a polarization conversion is proposed.

Abdelrazik Sebak, Ph.D., P.Eng., IEEE Fellow, EIC Fellow

Dr Abdel Sebak is a Tier I Concordia University Research Chair in mm-wave antennas and systems. Before joining Concordia University, he was a professor at the University of Manitoba. He was also with Cairo University and worked with the Canadian Marconi Company on the design of microstrip phased array antennas.

Dr Sebak's recent research activities cover two streams: Antenna Engineering, and Analytical and Computational Electromagnetics. Applied and sponsored projects include high gain mm-wave antennas, advanced composite materials for aerospace shielding and antenna applications, microwave sensing and imaging, ultra-wideband antennas, and microwave beamforming. Dr. Sebak's original research contributions and technical leadership have been extensive and resulted in over 500 publications in prestigious refereed journals and international conference proceedings.

Dr Sebak was inducted as a Fellow of the Institute of Electrical and Electronics Engineers in 2009. He is also a Fellow of the Engineering Institute of Canada. Dr. Sebak is a member of Concordia University Provost's Circle of Distinction for his career achievements. For his joint efforts in establishing one of the most advanced electromagnetic computational and antennas labs at the University of Manitoba, Dr. Sebak received the Rh Award for Outstanding Contributions to Scholarship and Research. Dr. Sebak received the 1992 and 2000 University of Manitoba Merit Award for outstanding Teaching and Research. In 1996 Dr. Sebak received the Faculty of Engineering Superior Academic Performance.

Dr Sebak has also received the IEEE Antennas and Propagation Society Best Chapter Award.

Dr. Sebak is serving as the Co-Chair of Publicity Committee of the 2020 IEEE Antennas and Propagation Symposium, and has served as the General Chair of IEEE-ANTEM2016 Symposium and Co-Chair of the IEEE ICUWB2015. He has also served as Chair for the IEEE Canada Awards and Recognition Committee (2002-2004), IEEE Canada Conference Committee (2000-2002) and as the Technical Program Chair for the 2002 IEEE CCECE Conference and the 2006 URSI-ANTEM Symposium. He has also served as a member (2002-2004) of the IEEE RAB Awards and Recognition Committee. Dr. Sebak has served as Associate Editor, Journal of Applied Computational Electromagnetic Society, Associate Editor, International Journal of Antennas and Propagation. Associate Editor, J. Engineering Research. He is a member of the Canadian National Committee of International Union of Radio Science (URSI) Commission B.

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DAY 1

I. Electromagnetic Waves

1.

Design Optimization for High-Gain Quad-Array of Helical Antennas for Satellites Applications

Maha Maged, Mohammed El-Telbany, and Abdelrahman El-Akhdar

Abstract
This paper presents a design of a high-gain quad-array of helical antennas placed inside a truncat-ed horn ground plane for satellites applications. The antennas within the truncated horn produce a circularly polarized and low side-lobe level. The gain in radiating direction is about 19:6dBi in the operating frequency range, which is more than 3dBi than of quad-array using a square ground plane and lower side-lobes. The design of the truncated horn is obtained by optimiza-tion process using genetic algorithms.

Keywords
helical antenna, array, ground plane, optimization, genetic algorithms.

2.

C-Band SIW Slot Synthetic Aperture Radar Antenna for Remote Sensing Applications

Maha Maged, Ahmed Ali Yousef1, Haitham Akah and Essam El-Diwany

Abstract
This paper presents a substrate integrated waveguide (SIW) slot array antenna designed for synthetic aperture radar (SAR) to be mounted on small satellites. This prototype single-layer dual-polarized C-band antenna was designed and simulated with the concern of remote sensing applications. The simulation results showed that the designed antenna has excellent radiation characteristics such as bandwidth, gain, and sidelobe level (SLL), with values 290 MHz, 17.9 dB, and −13.6 dB, respectively..

Keywords
Substrate Integrated Waveguide (SIW), slot antenna array, synthetic aperture radar, remote sens-ing.

3.

Ultra-wideband compact T-junction with optimized V cut for millimeter wave applications

Islam Afifi, Abduladeem Beltayib, and Abdel Razik Sebak

Abstract
In this paper, an Ultra-wideband printed ridge gap T-junction is presented. A T-junction is an e ssential component in feeding antenna arrays and power division networks. The printed ridge gap technology is selected as it has a low profile, supports quasi-TEM mode, and has very low losses. The design depends on using one quarter wave transformer and optimized V cut for wideband matching where the genetic algorithm is used for the optimization. The device has a compact size and a wide bandwidth from 25.18 to 40.52 GHz (46.7%).

Keywords
Millimeter waves components, Printed ridge gap, Power divider, Wideband.

4.

Excitation of the first High order mode in Ridge Gap Wave-guide

Abduladeem Beltayib, Islam Afifi, and Abdel Razik Sebak

Abstract
In this paper, a method to excite the first higher order mode of the ridge gap waveguide (RGW) is introduced. The fundamental mode of the RGW is well studied in a lot of papers while the higher order modes are ignored. However, they have some good properties that make them suitable for specific applications. The higher order modes can exist by having a ridgeline. In the proposed work, the excitation of the first higher order modes is achieved by having an L transition and vias that converts the fundamental Quasi-TEM mode of the RGW to the first higher order mode (first odd mode) and suppress the even modes. The proposed transition has a simple configuration and designed by using metallic (RGW) technology. The proposed structure is simulated using a full wave simulator (CST Microwave Studio).

Keywords
Ridge gap waveguide, high order mode, millimeter wave.

5.

Double Via Rows Radial Four-Way Power Combiner with Improved Isolation Performance

Abdelrahman El-Akhdar, Maha Maged, and Mohammed El-Telbany

Abstract
In this paper, a radial four-way combiner based on double via rows substrate integrated waveguide (SIW) with SMA-connector input and output ports are designed and simulated. The proposed combiner has an advantage of reduced leakage obtained by using double via rows con- figuration and improved isolation by optimizing the isolation wall length. The proposed radial power combiner can be easily fabricated using traditional PCB fabrication facility. The characteristics of the simulated combiner are evaluated. The return loss at the center port is higher than −33 dB for a 2% bandwidth around the center design frequency. The maximal loss is less than 1dB within the operating frequency band. The impedance of each port is 50Ω SMA connectors as a matching system.

Keywords
Substrate integrated waveguide (SIW), radial power combiner, double via rows.

6.

Using Geometric Algebra for Formulating Electromagnetic Propagation Ray Tracing Preprocessing

Ahmad H. Eid, Sherif M. Abuelenin, and Heba Y. Soliman

Abstract
Ray Tracing is an effective computational electromagnetic method that is used for studying electromagnetic wave propagation in complex scenarios. In this paper, we present the formulation of the geometric processing of electromagnetic ray tracing using Geometric Algebra. The presented formulation is more compact and uniform, and geometrically significant compared to traditional formulations based on linear algebra. Simulation results show the correctness of the presented geometric processing formulations.

Keywords
Computational Electromagnetics, Geometrical Optics, Geometric Algebra, Ray Tracing.

II. Solid-State Electronics

7.

Transport Properties of Ferromagnetic Silicene Superlattice based Nanostructure

Ahmed Saeed Abdelrazek Bayoumi and Adel Helmy Phillips

Abstract

A study of the properties of spin transport for ferromagnetic silicene superlattice field effect transistor taking into account the induced ac-field at various frequencies and applied mag-netic field is presented. The valley resolved conductance and spin resolved conductance are de-duced using transfer matrix method and Landuaer Butticker equation. The spin polarization is expressed in terms of spin resolved conductance of both spin alignments. While valley polariza-tion is expressed in terms of valley resolved conductance of both K and K' points. The ob-tained results show sharp resonant peaks with specific widths for both valley and spin depend-ent conductance. These resonant sharp peaks might be due to the effect of induced photon ener-gy of applied ac-field and magnetic field. The present research might have an applied scientific potential in the design and understanding of silicene superlattice based nanodevices and spin fil-ters by optimizing the investigated parameters.

Keywords

Spin and valley polarizations, normal and ferromagnetic silicene superlattice, fer-romagnetic insulator EuO, electric field, ac-field with different frequencies.

8.

3D Analytical Modeling of Potential, Drain Current, and Threshold Characteristics for Long-Channel Square Gate-All-Around (SGAA) MOSFETs

Hamdy Abdelhamid, Azza M. Anis, Mohamed E. Aboulwafa, and Mohamed I. Eladawy

Abstract
Gate-all-around (GAA) based field effect transistors (FETs) are considered to be one of the dominant structures that overcome the performance degradation problems that facing complementary metal oxide semiconductor (CMOS) technology in the nano meter scale. This paper pre-sents a three dimensional (3D) analytical model for electrostatic potential in the channel of the lightly doped n-channel square GAA MOSFETs. The model is based on the solution of the 3D Poisson's equation with mobile carriers. Based on the developed potential model and the current continuity equation, models for the drain current, the transconductance, and the output conductance are presented. Additionally, the threshold voltage and the short channel characteristics such as threshold voltage roll off (Roll-Off), drain induced barrier lowering (DIBL), and subthreshold swing (SS) are also analyzed at different biasing values and device parameters. The results of the proposed models are compared with those obtained by COMSOL 3D simula-tions and the results show reasonable agreement.

Keywords
GAA MOSFETs, Modeling, 3D Electrostatic Potential, Drain Current, Short Channel Ef-fects.

9.

Optimal parameter estimation of solid oxide fuel cells model using coyote optimization algorithm

Amlak Abaza, Ragab A. El Sehiemy and Ahmed Saeed Abdelrazek Bayoumi

Abstract
A Coyote optimization algorithm (COA) is used to estimate accurate model parameters of SOFC stack. The COA is a new bio-inspired optimization algorithm dependent on the behav-ior of a population of coyotes. In COA, the coyotes adapt in intelligent manner their social be-havior, interact and exchange experiences among them to reach the objective. COA is rapid, smooth, and steady in convergence process. In addition, COA differs from other algorithms those require more efforts to adjust the control variable of the algorithm. In this paper, the COA results are compared to parameters estimated from a modern applied technique ranking teaching-learning optimizer RTLBO. The proposed COA leads to more accurate parameters with good convergences for different operating conditions of SOFC.

Keywords
Coyote optimization algorithm; fuel cell, SOFC parameter estimation, SOFC operation conditions.

10.

Simulation Study of Terahertz Radiation Coupling Inside Field Effect Transistors

Marwa Mohamed, Nihal Ibrahim

Abstract
Field Effect transistors have been used lately for detection terahertz radiation beyond their cut off frequency. The contacts are expected to play a significant role in detecting this high frequency radiation. However, the effect of AC signal coupling between those contacts and the FET itself in this frequency range is not well known. In this work, a simulation study was conducted to extract the characteristic impedance of the contacts and the FET channel input, and these were used to extract the scattering coefficient. The results indicate that it's possible to reach high pow-er delivery rates in this frequency range. The results also indicated that the selection of the input terminal can affect the operation frequency range, and that the gate potential can largely affect the overall signal coupling. And finally, the results indicate the possibility of operating the contacts-FET coupling at an LC resonance condition subject to proper tuning of the system impedance.

Keywords
FET, Terahertz radiation detection, contacts coupling.

11.

Second Order Rectification of high frequency Radiation In Bipolar Junction Transistor

Ahmed M Elsayed1, Hassan M Emam, Hussein S Ahmed1, Yousof O Moustafa, Nihal Y Ibrahim

Abstract
Broadband rectification of high frequency electromagnetic radiation has been observed in field effect transistors and heterostructure transistors. It was used for terahertz radiation detection and imaging. In this work we report experimental evidence of rectification in bipolar junction tran-sistor beyond its cutoff frequency. We used discrete off-the-shelf NPN bipolar junction transistor to detect high frequency electromagnetic radiation. The incident radiation was shown to exceed the transistor's cutoff frequency. Despite the complete decay of the AC component, we have shown that the DC characteristics of the transistor showed nonlinear dependence on the incident radiation. We suggest that this response is second order rectification of the incident radiation. In this case, current models of second order rectification need to be revised to account for the phys-ics of bipolar transistors.

Keywords
Rectification, Radiation Detection, Bipolar Junction Transistors, cutoff frequency.

12.

Structural and optical properties of thin layers of zinc oxide under the effect of micro-droplet doping

N. Hamzaoui, M. Ghamnia, A. Boukhachem3

Abstract

Zinc oxide (ZnO) is a binary material, a semiconductor with a large direct gap (3.3 eV). With their good optoelectronic properties, thin films find several applications such as: solar cells, gas sensors, sensors piezoelectric... etc. In these work, thin films of Aluminum doped zinc oxide and Lithium doped zinc oxide are obtained using a simple process called micro-droplet. The synthesized samples were characterized by X-ray diffraction (XRD), atomic force microscope (AFM) and UV-visible spectroscopy. X-ray diffraction (XRD) analysis reveals that, thanks to the incorporation of Aluminum or Lithium, all the thin films prepared are well crystallized in the structure of wurtzite with the preferential orientation (002) in the direction parallel to the C axis. The morphology of the surface of the doped ZnO layers is studied by AFM atomic force microscopy showed less rough images as well as the surface topography was measured between 4 and 10 nm. The optical study by UV-visible spectroscopy revealed a high transparency of the order of 80% and a visible domain emission linked to the doped ZnO compound.

Keywords

Zinc Oxide, micro-droplet, X-ray diffraction

DAY 2

III. Information Technology

13.

Robust GPS Anti-Jamming Technique Based on Fast Orthogonal Search

Mohamed Tamazin and Aboelmagd Noureldin

Abstract
Despite the major significant in signal processing methods used nowadays, GPS receivers still face substantial challenges, such as jamming, which remains a dominant source of ranging er-ror. The presence of GPS jamming influences the acquisition and tracking modules inside the receiver leading to biased measurements or loss of lock of the GPS satellite signal. Consequently, GPS receivers cannot provide reliable position, velocity and time solutions. The main aim of this research is to introduce a robust GPS anti-jamming technique based on fast orthogonal search (FOS). A SPIRENT GSS6700 GPS simulator is utilized to examine the performance of the proposed methods under deep jamming scenarios. The robustness of the proposed method is compared to the performance of the NovAtel Propak V2 commercial receiver under simulated jamming scenarios. The solution availability of the proposed method is increased by 72% compared to the commercial GPS receiver.

Keywords
GPS, Jamming, Fast Orthogonal Search.

14.

New algorithm based on S transform to increase defects resolution within ultrasonic images

Ahmed Benyahia, Ahmad Osman, Abdessalem Benammar and Abderrezak Guessoum

Abstract
Recent years have seen a notable advance in the quality of produced industrial ultrasonic data. This is due to two main factors. From one side, advances on hardware level permitted to design and trigger ultrasound sensing arrays and matrices that led to new acquisition strategies such as phased array method and full matrix capture technique. From another side, development of algorithms and software components to reconstruct and process the measured data allowed a major improvement of the signal and image quality. Within this aspect, modern signal processing algorithms improved the defect resolution and thus their detection in ultrasound data. Mostly, methods based on time–frequency analysis are used. The measure of the improvement resulting from the signal processing methodology can be confirmed for instance by evaluating A-scans containing defects near the front and the back wall of inspected specimens. In this work, we describe a novel algorithm for processing one, two or three-dimensional ultrasonic data, in order to increase their defects resolution. The algorithm is demonstrated using simulation phantom as well as on a real specimen both including defects at different depths. The proposed enhancement method is based on Stockwell transform and normalized Hilbert envelope. Proposed method can effectively improve the quality of the ultrasound data.

Keywords
ultrasound, B-scans, defects enhancement, Stockwell transform, Hilbert envelope, thresholding.

15.

Reinforcement Learning for an Adaptive Personalized Platform for an Effective and Advanced Learning

Wafaa S. Sayed, Mostafa Gamal, Moemen Abdelrazek, and Samah El-Tantawy

Abstract

This paper proposes an artificial intelligence-based adaptive personalized platform for an effective and advanced learning. Most e-learning platforms target adult and lifelong learners. Yet, the educational process for younger people can be much enhanced through e-learning and Artificial Intelligence (AI) support to suit each learner's pace and learning style. In addition, it complements the role of classroom teacher in providing one-to-one tutoring for each learner, which is matched to his/her capabilities, preferences and needs. Based on the mathematical definition of the problem, it is found that Reinforcement Learning (RL) is the most suitable AI technique for the proposed adaptive personalized e-learning system for school students. A literature review of the related research works is provided focusing on personalized e-learning systems for school students on one hand and utilizing RL in this problem on the other hand. Learning styles: Visual/ Aural/Read, write/Kinesthetic (VARK) and Bloom's taxonomy are considered in the proposed system design. A website is designed based on Moodle Learning Management System (LMS) as the e-learning platform. An Artificial Intelligence Module (AIM) responsible for adaptation is developed using multi-task deep Q-learning. The module is implemented and trained using an ε -greedy policy. Its performance is evaluated using the running mean of the reward function, the total taxonomy loss and the VARK loss. The performance metrics validate the convergence of the RL algorithm.

Keywords

Adaptive personalized E-learning, Artificial Intelligence, Bloom's taxonomy, Learning styles, Multi-task deep Q-learning, Primary school education, Reinforcement learning, ε -greedy policy

16.

A Context-Aware Motion Mode Recognition System Using Embedded Inertial Sensors in Portable Smart Devices

Omar Sheishaa, Mohamed Tamazin and Iman Morsi

Abstract

. The expeditious market transformation to smart portable devices has created an opportunity to support activity recognition using the embedded sensors of these devices. Over the last decade, many activity recognition approaches have been proposed for various activities in different settings. The motion mode recognition or transition in modes of the device is needed in many technological domains. This approach detects a variety of motion modes for a human using a portable device. The approach includes many aspects: usability, mounting and data acquisition, sensors used, signal processing, methods employed, features extracted, and classification techniques. This paper sums up with a comparison of the performance of several motion mode recognition techniques. In this research, multiple behaviors were distinguished using embedded inertial sensors in portable smart devices. In our experiments, we selected four types of human activity, which are walking, standing, sitting and running. A combination of one of the embedded mobile sensors and machine learning techniques have been proposed in order to do this kind of classification. The proposed system relies on accelerometers data to classify user activities. The results show that using SVM classifier showed better accuracy for detection compared to the outcomes of the other classifiers like KNN and Ensemble classifiers. For future work, classification of other human activities like cycling, driving and swimming will be investigated.

Keywords

Motion Mode Recognition, Machine Learning, Smartphone Accelerometer Data.

17.

Color Restoration Survey and an Overdetermined System for Color Retrieval from Faded Images

Devin Haslam, Soad Ibrahim, Ayman Elmesalami

Abstract

This paper presents a survey of the most widely used color restoration techniques from faded images. The purpose of the survey is to explain the reasons for color fading and emphasize how the color restoration techniques have evolved in recent years. The survey covers the color bleach-ing models, single-scale and multi-scale retinex, gray world, max white, machine learning, and underwater color correction approaches. Image colorization, inpainting, and color constancy as-pects are discussed in the machine learning portion of this survey. Numerous color restoration approaches are reviewed under the uncategorized techniques. An overdetermined system for re-trieving the degraded color components from old faded images is presented as part of this sur-vey. The system reviews three different approaches which combine the traditional max white, gray world, and retinex white balancing algorithms. In each approach, one of the three algo-rithms is eliminated while the other two are combined by a set of second order equations.

Keywords

Color retrieval, color restoration, faded colors, degraded colors, faded images, color restoration survey, color retrieval survey.

DAY 3

IV. Engineering Mathematics

18.

State Dependent Parameter PID+ Control Applied to a Nonlinear Manipulator Arm

H. Sayed, E. M. Shaban, A. Abdelhamid

Abstract
The successful implementation of the PID+ control persuades the authors to investigate the same controller using the state dependent parameters transfer function (SDP-TF) model, so as to improve the performance of PID+ control when used on nonlinear systems. For this reason, this paper introduces the SDP-PID+ control, for which the PID+ control is used on the four-degrees of freedom manipulator arm when modeled using SDP model structure, where the parameters of the TF change as a function of the state variables. Here, the additional input and proportional compensators exist in the PID+ approach fight the effect of the discrete time SDP-TF associated with samples time delay greater than unity and order greater than two. These additional compensators enable the using of the full state feedback to develop the time variant state variable feedback (SDP-SVF) control action for the SDP-PID+ controller. In this work, two tuning techniques are introduced for the SDP-PID+ controller; they are the LQ cost function through using the SDP-NMSS of the SDP-TF model and the pole placement. Both approaches provide an appropriate performance in addition to reject output and input disturbance with retrieving the zero steady state error in a suitable time.

Keywords
discrete PID+ control, discrete-time nonlinear system, state dependent parameter (SDP) model, SDP pole placement, non-minimal state space (NMSS) form, linear quadratic (LQ) optimization.

19.

Sliding mode control with PID surface for robot manipulator Optimized by evolutionary algorithms

Fatiha Loucif and Sihem Kechida

Abstract
In this study, sliding mode controller (SMC) with PID surface is designed for the trajectory tracking control of robot manipulator using Antlion Optimization Algorithm (ALO) compared with another technique called (Grey Wolf Optimizer) GWO. The idea is to determinate optimal parameters (Kp, Ki, Kd and lamda) ensuring best performance of Robot manipulator system minimizing the integral time absolute error criterion (ITAE) or the integral time square error criterion (ISTE), the modeling and the control of the robot manipulator was realized in MATLAB environment. the simulation results prove the superiority of ALO in comparison with GWO algorithm.

Keywords
Sliding mode control, PID sliding surface, Nonlinear control, robot manipulator.

20.

Error analysis of nonlinear WENO schemes using modified equation

Tamer Kasem

Abstract
A theoretical study of the nonlinear Weighted Essentially Non-Oscillatory (WENO) method is presented. Single and multi-step explicit numerical time integration algorithms are covered. The main idea is adopting the modified equation method. The necessary lengthy derivations are achieved using a computer algebra system. Accurate theoretical estimates of error norms are derived. The introduced theoretical results are validated via quantitative comparison with numerical experiments.

Keywords
WENO, Non-linearity, Modified Equation, Error Norm

21.

Enhanced Modified-Polygon Method for Point-in-Polygon Problem

Mostafa El-Salamony, and Amr Guaily

Abstract
The present contribution is an extension to our previously published algorithm, Modified-Polygon Method (MPM) in which we modified the algorithm to account for the case of slen-der bodies which was a drawback in the original work. The modification is O(N) in time. The modified algorithm is tested against existing techniques with an apparent degree of success.

Keywords
Point in polygon; modified area; arbitrary polygon; slender bodies.

VI. Engineering Mechanics

22.

EL NIŃO (2014-2016) and La Nino (2010-2012): Their Impacts on Water Cycle Components.

Muhammed Eltahan, Karim Moharm, Mohammed Magooda

Abstract

ELNino and La Nino are considered one of the most important phenomenons over Pacific Ocean that affect the complex earth system and have great impact and contribution to the weather and climate change. Investigation the spatiotemporal analysis and trend is critical to un-derstand the warm and cold phases of the El Niño–Southern Oscillation (ENSO) which are ELNino and La Nino. In this work, the spatial distribution of temperature ,precipitation and evaporation over the pacific ocean are investigated during the two different El Nino event (2014-2016) and La Nino Event (2016-2017). Three different data sources was included in this study, temperature from remote satellite sensor Moderate-resolution Imaging Spectroradiometer (MODIS) , precipitation from Tropical Rainfall Measuring Mission (TRMM) satellite space mission and evaporation from NASA Numerical climate model Modern Era Retrospective-Analysis for Research and Applications (MERRA). This work reveals how El Nino and La Nino events impact the water cycle components.

Keywords

EL Nino, La Nino, Climate Change,MODIS,TRMM, MERRA

23.

Frequency scaling in a sweeping-jet fluidic oscillator working at low Reynolds numbers: A Multiple-Relaxation Time LBM model

Mohammed A. Boraey

Abstract
The operation of a sweeping-jet fluidic oscillator (FO) is numerically investigated at low Reyn-olds number range using the Multiple Relaxation Time Lattice Boltzmann Method (MRT-LBM). The scaling between the normalized oscillation frequency (i.e. Strouhal number) and the operating Reynold number is established. The lower limit of the investigated range of the Reynolds number is the one corresponding to the onset of oscillation (i.e. below which steady-state operation exists). The oscillation frequency and amplitude were found to scale linearly with the Reynolds number. The results are useful is application where the maximum flow rate is limited due to other design constraints and hence the cyclic behavior of FO are required at the lower Reynolds number range.

Keywords
Fluidic Oscillator, Low Reynolds number, Multiple-Relaxation Time Lattice Boltzmann Method

VII. Applications in Mechanical Engneering

24.

Transient temperature profiles in powder beds during additive manufacturing by 3D printing of metal powders: A Lattice Boltzmann Study

Mohammed A. Boraey

Abstract
The present work aims at predicting the transient temperature profiles in the powder beds of metals powders during the 3D printing of metals using laser melting. The effects of the laser beam power, diameter and speed on the developed temperature profiles are predicted using the Lattice Boltzmann Method (LBM). These profiles are needed to predict the behavior of the powder bed during the 3D printing process which affects many manufacturing parameters like the production speed, the product quality and properties. The results show that a compromise has to be made between the laser beam speed, which directly affects the production speed, and the developed depth of the heated zone in the powder bed, which determines how many laser passes are needed for a specific product.

Keywords
3D printing of metals, Temperature profiles, The Lattice Boltzmann Method

25.

Numerical and Experimental Validation of an Unbalanced Oil Vane Pump using RANS Approach

Ahmed H. El-Hennawi, Muhammed Eltahan, Mohammed Magooda, Karim Moharm

Abstract
Positive displacement pumps have a wide range of usage due to its compact size and efficiency as well. Vane pump is a positive displacement pump with many applications such as keeping the oil supply of the engines in the automotive and the fuel pumping in aviation industries. Pump testing is a direct technique to know its performance however, it costs a lot to see the be-havior of the fluid during the pump operation experimentally. Computational fluid dynamics (CFD) programs were developed to be another method in pump optimization as a result of its low cost and high speed. In this paper, a validation process for a four-vanes unbalanced pump model will be conducted, by comparing the results of the numerical model with the experi-mental results. The three-dimensional model was built up and simulated using ANSYS (FLUENT). An experiment was held on a four-vanes pump test rig, at the Mechanical Power Department of Ain-Shams University. The results of the simulated model have compared with the pump experimental results and gave a good agreement, with a maximum deviation of<6 % in the flow rate.

Keywords
RANS approach; vane pump; computational fluid dynamics; model validation.

26.

Numerical Study of an Unbalanced Oil Vane Pump using Sher Stress Transport (SST) k – W Turbulence Model

Ahmed H. El-Hennawi, Muhammed Eltahan, Mohammed Magooda, Karim Moharm

Abstract
Vane pumps have several applications in the automotive and aviation industries. Many factors affect pump performance. So, modifying the Pump design plays an important role in pump performance and efficiency. Computational Fluid Dynamics (CFD) techniques, became an adequate tool to design and optimize the pump as it can save time and cost. In this paper, a parametric study for an unbalanced vane pump model will be shown, by studying the effect of two parameters which are the model vanes-number and the gap-height between the vane tip and the pump casing. A three-dimensional model was built and simulated using ANSYS (FLUENT). The shear stress transport (SST) K-W turbulence model was used in all simulations. Three different gap-heights and three different vanes-number models were simulat-ed. The model with gap height of 0.1 mm gave the best flowrate and output power. Moreover, three models with (4, 6 and 8 rotor-vanes) were modeled. The characteristic map was deter-mined, and the eight-vanes model gave the best output flowrate.

Keywords
(SST) K-W turbulence model; vane pump; computational fluid dynamics; RANS approach.

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