International Conference on Recent Trends in Applied Sciences and Physical Sciences Using Machine Learning Techniques

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Preface

The International Conference on Recent Trends in Applied Sciences and Physical Sciences using Machine Learning Techniques, is being organized by the Northcap University on 13th and 14th April. This conference brings together researchers, academicians, and practitioners from various fields to explore the intersection of Machine Learning (ML) and Applied Sciences.

With a focus on mathematics, physics, chemistry, and bioinformatics, this conference provides an inclusive platform for discussions and research on how ML can be leveraged to characterize true probability distributions of nature.

Through engaging presentations, insightful discussions, and collaborative networking, this conference aims to advance the frontier of knowledge in the field of ML and its applications in the physical sciences. Join us in this exciting endeavor to explore the latest trends, share cutting-edge research, and foster interdisciplinary collaborations at the forefront of ML and Applied Sciences.

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- Dr. Lena Yadgarov, Ariel University, Israel

National Speakers

- Prof. R.K. Agarwal, JawaharLal Nehru University, India
- Prof. Kehar Singh, Former Professor, IIT Delhi, India
- Dr. Mukesh Jewariya, National Physical Laboratory, New Delhi, India
- Prof. Sudhansh, Indira Gandhi National Open University, India

Contents

A Computational Study on the Effect of Extended Conjugation on the Photosensitizers for DSSC Using DFT and TD-DFT Methods

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Abstract

Dye sensitized solar cells have achieved more than 12% efficiency[1][2] since 1991 when first metal organic photosensitizer was made by Gratzel based on ruthenium complex[3]. Here we have discussed the effect of extended conjugation on absorption spectra of the photosensitizers[4]. The designed dye molecules are based on donor- π -acceptor model. The designed dyes are named as S1 [**naphthalene-pyrrole-butanoic acid**] and S2 [**naphthalene-pyrrole-thiophene-butanoic acid**]. Both the systems are optimized under the framework of density functional theory using B3LYP hybrid functional with 6-31+G(d,p) basis set. The absorption spectra is calculated utilizing time dependent density functional theory at CAM-B3LYP functional on Gaussian 16W software. The calculated absorption maxima of the S1 are at 286.66 nm and for S2 the absorption maxima are observed at 296.89 nm. The frontier molecular orbital energy gap HOMO-LUMO for S1 is found at 4.34 eV and for S2 it is 3.75 eV. This shows that the HLG energy reduces on increasing the π bridge molecule in the system which enhances the absorption maxima towards the red shift of the visible spectrum. The red shift of 10.23 nm in the absorption spectra is observed in the S2 system as compared to the S1. Thus, the effect of bridging on the absorption maxima shows that conjugation length plays a key role in enhancing the absorption spectra for the designed photosensitizer. Therefore, this study would help in designing the novel conjugated organic molecules as better photosensitizers for high-performance DSSCs. The reported dyes would be interesting for further experimental research.

Keywords: *Photosensitizer; DSSC; Donor- π- Acceptor; DFT; TDDFT.*

Advancing Perovskite Solar Cells Through Machine Learning Techniques

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Abstract

Perovskite solar cells have recently emerged as a promising technology for achieving high efficiency, low-cost photovoltaic energy conversion, simple fabrication process, flyable, light wearable and low cost materials constituents. From the last decade, solar energy an abundant and cheap energy is one of the most promising renewable energy sources.(1) Over the last few years, the efficiency of perovskite solar cells have surpassed 25% due to high quality perovskites-film deposited through low temperature synthesis techniques along with suitable interface and electron materials.(2) The stability of perovskite solar cells has attracted much well deserved attention. Machine learning (ML) techniques, a branch of artificial intelligence, have been applied to various aspects of perovskite solar cells, including materials discovery, device design, and optimization. This approach has the potential to accelerate the development of perovskite solar cells by enabling the prediction of new materials, optimizing device parameters, and identifying optimal processing conditions.

In this paper, an overview of the current state of the art in ML-based perovskite solar cells, including the various ML techniques used, the challenges and opportunities of applying ML in this field, and the future prospects for advancing the development of perovskite solar cell, recent progress of the perovskites solar cells regarding their crystallinity, morphology and synthesis techniques has been reported. Outlook of various types of materials which are used to prepare perovskites solar cells and their potential of commercialization has also been discussed.

Keyword: *Perovskite solar cells, Machine learning, Power conversion efficiency.*

Data Analytic Insights in the Development of a Phase Change Material Using Machine Learning

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Abstract

Keeping in mind the sustainable development goal, India has the vision to achieve Net Zero Emissions by 2070 in addition to short-term targets. Thermal Energy Storage (TES) can help substantially in meeting the vision of energy efficiency. Phase Change Materials (PCMs) can absorb, store, and release heat energy on demand and are widely used in various TES applications. A PCM of phase change temperature of 20°C was developed using data analytic insights from machine learning (ML). The experiments were planned from the formulation predictions using the ML engine. The paper reports insights into the effects of primary ingredients on the properties such as melting temperature, crystallization temperature, enthalpy, and nucleation temperature. Predicted and observed properties are compared and studied. Calcium chloride,calcium bromide, and water were used as the primary ingredients. Calcium chloride, calcium bromide, and water showed the most positive effects on enthalpy, nucleation temperature, and melting and freezing temperatures, respectively. The insights of two different ingredients on a single property are also discussed in the paper. The developed PCM showed a melting temperature of 23°C, a freezing temperature of 20°C, and latent and specific heat of 140 kJ/kg of 2.7 kJ/kg-K, respectively with negligible supercooling.

Keywords: *Machine Learning, Phase Change Materials, Thermal Energy storage.*

Design and Performance Analysis of Low Pass Filter using Hamming and Kaiser Windows

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Abstract

A digital low-pass filter is a type of electronic filter that allows low-frequency signals to pass through while attenuating high-frequency signals. It is implemented using digital signal processing techniques and is widely used in various applications such as audio processing, image processing and communications. The digital low-pass filter works by processing a discrete-time signal and applying a mathematical algorithm to remove or reduce the high-frequency components of the signal. The filter is characterized by several parameters such as cut-off frequency, filter order, and stopband attenuation, which determine its performance. One advantage of digital low-pass filters over analogue filters is their ease of implementation and flexibility in adjusting filter parameters. Additionally, they can be easily programmed and adjusted using software, making them suitable for real-time applications. Digital low pass filters can be implemented using various algorithms, including Finite Impulse Response (FIR) and Infinite Impulse Response (IIR) filters. The choice of algorithm depends on the specific application and the desired characteristics of the filter, such as passband ripple, stopband attenuation, and transition bandwidth.

This paper presents the design and performance analysis of Low Pass Filter. Hamming and Kaiser Windows techniques are used along with Rectangular window technique for the design analysis by using Python for simulation and performance analysis. The filter design is based on the Finite Impulse Response (FIR) technique and aims to eliminate high frequency noise from the input signal while preserving the desired low frequency components. The Hamming and Kaiser windows are compared for their performance in terms of stopband attenuation, passband ripple, and transition bandwidth. The design is implemented using Python simulation and the results show that both the Hamming and Kaiser windows are effective in reducing high-frequency noise. However, the Kaiser window provides better performance in terms of stopband attenuation and passband ripple, with a transition bandwidth of 10% compared to 20% for the Hamming window. The hardware implementation of the filter is done on a FPGA development board and the results show that the filter is able to process a 16-bit 48 kHz audio signal in real-time with a clock frequency of 50 MHz . The filter is shown to be effective in reducing high-frequency noise from the input signal while preserving the desired low-frequency components. The proposed filter has potential applications in various signal processing applications, such as image and speech processing.

Keywords: *Low pass filter, Hamming Window, Kaiser Window, FIR filter, stopband attenuation, passband ripple, transition band, signal processing, frequency response.*

Improved Asymmetric Cryptosystem based on Triple Random Phase Encoding using UMD and Gyrator Transform

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Abstract

In this paper, an asymmetric cryptosystem based on Triple random phase encoding (TRPE) is proposed with the help of Unequal modulus decomposition (UMD) and the gyrator transform (GT). UMD provides extra keys to the cryptosystem and parameters like transform angle of the gyrator transform enhance the security of the cryptosystem This scheme is based on triple random phase encoding the effectiveness of the scheme is tested using MATLAB (2022a). Key sensitivity analysis is also evaluated to check the resistance of this scheme.

Keywords: *Gyrator Transform, Unequal modulus principle (UMD), Random phase mask (RPM)***.**

Invariance Analysis, Generalized Closed-form Solutions and Dynamics of the Wave Profiles for the (2+1)-Dimensional Modified Dispersive Water Wave (mDWW) System of Equations

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Abstract

In this article, a (2+1)-dimensional modified dispersive water wave (mDWW) system of equations is investigated by employing the method of Lie group of invariance. The system describes the dispersive and non-linear long gravity waves, traveling on the shallow water of uniform depth into the two horizontal directions. With the aid of symbolic computation, the infinitesi mals generators are obtained. Using infinitesimal generators, the vector fields are obtained and corresponding to vector fields, the commutator table and the adjoint table are obtained. Furthermore, using the adjoint table, the one-dimensional optimal system of subalgebras is obtained. With the aid of the optimal system, the similarity reductions are performed for different cases. Finally, using the similarity reductions, the considered system of nonlinear partial differential equations (PDEs) is transformed into the system of ordinary differential equations (ODEs) by means of the Lie symmetry analysis to obtain the closed-form group invariant solutions. The graphs consist of the periodic solitons. Dromions and peakon excitations are captured in the graphical representations of the solutions. Using these graphs, mathematicians and physicists can follow the involved complicated physical phenomena more efficiently. The mDWW system is fully integrable and has numerous applications in tidal waves and ocean tsunamis.

In this paper, we have considered the following system of (2+1)-dimensional modified dispersive water wave (mDWW) system of equations for our study:

$$u_{yt} + u_{xxy} - 2v_{xx} - 2(uu_y)_x = 0,\ v_t - v_{xx} - 2(uv)_x = 0. \quad (1)$$

Here, u represents the horizontal velocity of water waves and v represents the elevation above the undisturbed surface of water, respectively. (x, y) and t represent the propagation and time scales, respectively. This mDWW system (1) is used to describe the dispersive nonlinear long gravity waves traveling in two horizontal directions on shallow water, which is of uniform depth.

Keywords: *Modified dispersive water wave (mDWW), Partial differential equations (PDEs)*

Perovskite Material History, Properties, and Current Applications

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Abstract

For more than a decade, perovskite material has been gaining attraction from the research community with its fantastic property like low fabrication cost, ability to process at low temperatures, and high performance. Perovskite material has a crystal structure with a chemical formula ABX3. The first ever discovered perovskite material is Calcium Titanium Oxide(CaTiO3) by Gustav Rose in 1839. Some physical properties that attract the research community towards it are ionic conductivity, superconductivity, and various dielectric properties. There are many applications of perovskite material in semiconductor devices like solar cells, light emitting diodes (LEDs), thin film transistors(TFTs), etc. The research community studied the perovskite solar cell in large quantities, and soon, solar panels made up of perovskite solar cells will be available for commercial use.

On the other hand, perovskite material in the field effect transistor needs more research in terms of fabrication and performance. The performance of the perovskite channel material in the field-effect transistor needs more attention from the scientific community. The hysteresis behavior is also one of the biggest challenges researchers face in perovskites field-effect transistors. Despite being a good performer, specific challenges must be addressed, like stability, toxicity, and ambient environment processing of perovskite materials. This work reported the brief history and application, along with essential properties of perovskite materials required for semiconductor device application.

Keywords: *perovskite solar cells, CaTiO3, stability, toxicity, perovskite history*

Transient Analysis of an Unreliable System with Working Vacation and threshold recovery

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Abstract

The study focuses on the analysis of the F-policy queuing system with single working vacation. The server is unreliable and can experience breakdown while serving customers. The repair process follows the concept of threshold recovery for the server failed. Transient analysis of the system is performed to investigate the effect of changes in the system parameters using the numerical approach based on fourth order Runge - Kutta method. Cost function is designed to analyze the system's cost.

Keywords: *Start-up time, Threshold recovery, Runge - Kutta (R-K) method, Cost analysis.*

Use of Machine Learning in Library Management System in C Language

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Abstract

In this era of upcoming new technologies,Artificial intelligence and machine learning have become major catalysts of reshaping the way we think and make decisions.Like any other fields library and information sector are also making full use of these technologies.Application Of AI and ML is helpful for effective management of different library system that ultimately shifts traditional library services to intelligent library system.They provide an array of possible tools to help libraries generate big data for digital resources.

Library management system In c language. A library management system enhances the effectiveness of both the librarian and library users.It also enables librarians to easily catalog books and keep proper records of books used,issued and reissued.

An important project extensively using file handling functions in C programming language.It is based on the concept to store details of books entered by the user.The admin can perform all the tasks like adding,viewing,modifying and deleting book records.There is a login system for admin. This program is considered as a simple database of book recording where the user can store book's records easily as its not time consuming.This project is easy to operate and understand by users. In order to run the project DEV C++ or Code blocks must be installed on PC.

Keywords: *Artificial Intelligence, Machine Learning, Programming.*

Using Machine Learning to Analyze Cyber Security

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Abstract

Machine learning is a subfield of artificial intelligence that focuses on the development of algorithms and statistical models that enable computer systems to learn from and make predictions or decisions based on data. The goal of machine learning is to develop models that can learn patterns and relationships in data without being explicitly programmed. Machine learning has become increasingly important in recent years due to the exponential growth of data, advances in computing power, and the need to automate decision-making processes.

There are several types of machine learning techniques, including supervised learning, unsupervised learning, semi-supervised learning, and reinforcement learning. Supervised learning involves training a model on labeled data, where the desired output is already known. Unsupervised learning involves training a model on unlabeled data to identify patterns or structures in the data. Semi-supervised learning involves training a model on a combination of labeled and unlabeled data. Reinforcement learning involves training a model to make decisions based on feedback received from the environment.

Machine learning has a wide range of applications, including image and speech recognition, natural language processing, predictive analytics, fraud detection, and recommendation systems. Machine learning algorithms have been used to improve medical diagnosis and treatment, optimize business processes, and enhance scientific research.

Keywords: *Artificial Intelligence, Machine Learning, Cyber Security.*

Dimensional and 3 Dimensional model of Particle Accelerator

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Abstract

Nuclear physics technology is ubiquitous in our lives. Many of today's most important advancements in medicine, materials, energy, security, climatology etc. emanate from applications of nuclear physics. Given the importance of applied nuclear physics, it is not surprising that applications are very often a significant section of the programs in accelerator facilities all over the world. A particle accelerator is a device that accelerates charged particles to high energies for scientific research, medical applications and industrial purposes. The design of a particle accelerator depends on the specific requirements of the experiment, such as the type of particles to be accelerated, the energy level required, and the precision and stability of the beam. According to eminent scientists J.J. Thomson, Rutherford, and J. Chadwick, they discovered the electron, proton, and neutron—three sub particles. We focus on the processes for producing new elements using particle accelerators right now. A process where a source material is used in a particle generator with a high voltage supply in order to separate the source's electrons and protons before passing them via a vacuum tube. The main components of a particle accelerator include a particle source, which produces the particles to be accelerated, an injector, which further accelerates the particles to the desired energy level, and a beam line, which guides and focuses the particle beam to the target. Protons move in a direction with the assistance of an electric field or magnetic field in a vacuum tube where they accelerate to a high speed that is slower than the speed of light. The next element is placed on which electrons or protons add or remove to change its properties to form another element or create a new element, after which a prism or crystal-type object is placed in the center of the particle accelerator to change the direction of electron or proton beams to the target. Nevertheless, because the new element is unstable (radioactive), it cannot be stabilized using a vacuum chamber or any other method that will be agreed upon later in the field of nuclear physics. In our accelerator design the magnetic and electric fields will be used to accelerate the particle beam and also the vacuum system will be required to maintain. If this theory is successful, new elements will replace several expensive or rare elements used in research or the production of various compounds. For source the elements can be used are palladium, lead, steel alloy, aluminum alloy brass, etc. For target materials Palladium core, copper alloy, manganese, zinc etc can be used. The design of the particle accelerator is shown in figure below.

Keywords: *Nuclear Physics, Particle accelerator, element.*

Comparative Analysis of Various Machine Learning Algorithms for Handwritten Digits Recognition

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Abstract

In order to develop a system to understand handwriting style that differs from person to person, includes a machine to recognize and classify the images of handwritten digits as ten digits. The focus is on recognizing the handwritten digits i.e. 0 to 9 from the well-known MNIST dataset. A comparative analysis of machine learning algorithms such as Decision tree, Naïve Bayes, k-nearest neighbours, Support vector machines, Convolutional Neural Network is presented. In order to test the efficiency of these algorithm, the dataset is preprocessed and given as input to the algorithm and its precision, recall, f1 score and accuracy are found and compared.

Keywords: *Handwritten digits, Machine learning, CNN.*

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