5TH IEEE INTERNATIONAL CONFERENCE ON ARTIFICIAL INTELLIGENCE IN ENGINEERING AND TECHNOLOGY

IICAIET 2023

12 - 14 SEPTEMBER 2023
KOTA KINABALU, MALAYSIA

Organised by:

IEEE

UMS
UNIVERSITI MALAYSIA SABAH

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MESSAGE FROM CHAIR

Dear respected participants,

It is my honour to welcome you to the 5th IEEE International Conference on Artificial Intelligence in Engineering and Technology 2023, IICAIET 2023.

Welcome to IICAIET 2023, and welcome to Sabah, the land below the wind!

This year's conference marks the first return to in-person IICAIET conference since the Covid-19 pandemic outbreak in 2020. Nonetheless, we have continued to meet virtually to share knowledge and connect with each other despite of such circumstances in the past few years. It is great to finally reconnect with you in person.

'Artificial Intelligence' has been making headlines in recent times with technologies such as ChatGPT pushing boundaries. This has caused a lot of discomfort among the general public, due to misconstrued point of views and talking points in the media. Aptly, one of the main focus of this year's conference is on how AI impacts society and humanity, in general, where we take a closer look into how AI has transformed our lives, and the importance of ethics when it comes to AI applications.

This year, we received more than 180 submissions. We have received submissions from Japan, China, Philippines, Hong Kong, Bangladesh, India, Brasil, UK, and so on, as well as from Malaysia. To uphold the standard of the conference, all the papers went through a rigorous reviewing process, which resulted in just more than 100 papers accepted to be presented. Over the course of these few days of conference, a total of 71 will be presented. Thank you for your participation in IICAIET 2023.

On behalf of the organising committee, I hope this year's conference offers a good platform for you to engage in meaningful and fruitful discussions.

Assoc. Prof. Dr. Renee Chin Ka Yin
Chair of IICAIET 2023

ABOUT IICAIET

IEEE International Conference on Artificial Intelligence in Engineering and Technology (IICAIET) is the annual flagship technical event of IEEE Sabah Subsection. The IICAIET conference series has gained great interests from scholars, researchers, academicians, professionals, and students in the Asia-Pacific Region, covering all over technical areas related to Artificial Intelligence.

The first ICAIET conference goes 20 years back to 2002, held in Kota Kinabalu, co-organized by Universiti Malaysia Sabah (UMS) and the Artificial Intelligence Research Unit (AiRU). ICAIET was subsequently held biannually in 2004 and 2006. Significant scientific findings towards the trend of Artificial Intelligence were presented by international and local participants who have attended ICAIET. The reviewed papers presented at the conference were then published as proceedings. With the establishment of the IEEE Sabah Subsection in 2018, ICAIET was then rebranded as IICAIET with IEEE sponsorship. ICAIET was subsequently held in 2020 before changing into annual event in 2021. With the technical sponsorship of IEEE Sabah Subsection, the conference proceeding for IICAIET 2018, IICAIET 2020, IICAIET 2021, IICAIET 2022 were published in IEEE Xplore and Scopus-indexed.

This year, IICAIET 2023 received 187 submissions. Upon review of all the submissions, 71 accepted papers will be presented orally during the conference.

We are proud to that IICAIET has become an important platform to exchange and discuss the new ideas, opinions, and prospects in Artificial Intelligence.

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JAMAL AHMAD DARGHAM

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Jamal Ahmad Dargham was born in a small village in the north of Lebanon. He received his BSc in Control Systems Engineering from the University of Technology, Iraq in 1984 and his MSc in Control Systems Engineering from the University of Manchester, UK, in 1987 and his PhD in Image Processing from Universiti Malaysia Sabah in 2008. He moved to Sabah, Malaysia in 1988 From 1989 till 1996 he was a lecturer at the Advanced Management College, Sabah. He was the first academician to join the School of Engineering and Information Technology, as the Faculty of Engineering used to be called, in 1996. He was the Program Head of Computer Engineering Program from 2006 till 2011, and Head of the Artificial Intelligence Research Unit from 2016 to 2018. His main research interests are in Image Processing specifically Biometrics, as well as Engineering Education. He has published more than 75 papers in refereed journals, conferences, book chapters and research reports. He has supervised more than 10 MSc. And PhD students, and was the examiner or more than 10 graduates at the Master and PhD levels locally and overseas. He has a long history with this conference from 2002. Until last year he was always a member of the organizing committee holding various posts including the chairperson post, but his favorite post is the local arrangement.

SAINARAYANAN GOPALAKRISHNAN

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Sainarayanan Gopalakrishnan obtained his B.E (Electronics & Instrumentation) from Annamalai University (1998) and M.E (Control Systems) from PSG College of Technology (2000), Ph.D in Image Processing from Universiti Malaysia Sabah (2003), Masters in Law (Intellectual Property Rights) in 2014 and also holds executive specialization on Advanced Strategy Management from Indian Institute of Management, Kozhikode. He holds 57 US Patent Grants and has published 125 technical publications as Books, Book Chapters, International Journals and Conferences proceedings in the area of computer vision and machine learning. Currently works as Technology Director in Engineering and Research Services of HCL Technologies Ltd., Chennai, India. He is a senior member of IEEE & serves in academic boards of several reputed universities.

KEYNOTE SPEAKERS

CONFERENCE PROGRAM

12 September 2023 Tuesday	
14:00 - 16:00	Registration
13 September 2023 Wednesday	
08:00 - 09:00	Registration
09:00 - 09:20	IICAIET 2023 Opening Ceremony
09:20 - 09:30	Photo Session
09:30 - 10:20	Keynote 1: Assoc. Prof. Dr. Jamal Ahmad Dargham *Universiti Malaysia Sabah, Malaysia* *Title: Artificial Intelligence (AI) and the Future of Mankind*
10:20 - 10:30	Tea Break
10:30 - 11:20	Keynote 2: Dr. Sainarayanan Gopalakrishnan *HCL Technologies LTD, India* *Title: Bridging the Computer Vision Dimensions: Intertwine of Data, Computing and Performance.*
11:20 - 11:30	Short Break
11:30 - 12:30	Parallel Session A A1: Data Augmentation and Utilisation A2: Smart Agriculture A3: Machine Learning in Agriculture Applications
12:30 - 14:00	Lunch
14:00 - 15:15	Parallel Session B B1: Intelligent Control and Robotics B2: Machine Learning in Behavioural Applications B3: Communication Technology
15:15 - 15:30	Tea Break
15:30 - 16:30	Parallel Session C C1: Smart Building C2: Machine Learning Applications
14 September 2023 Thursday	
08:00 - 09:00	Registration
09:00 - 10:15	Parallel Session D D1: Pattern Classification for Speech and Text Applications D2: Image Processing Applications
10:15 - 10:30	Tea Break
10:30 - 12:00	Parallel Session E E1: Machine Learning in Biomedical Applications E2: Internet of Things (IoT)
12:00 - 14:00	Lunch
14:00 - 15:15	Parallel Session F F1: Machine Learning Applications F2: Modelling and Simulation
15:15 - 15:30	Tea Break
15:30 - 16:30	Parallel Session G G1: Image and Signal Processing G2: Smart Energy

Session A1: Data Augmentation and Utilisation		
Session Chair: Associate Professor Dr. Jamal A. Dargham		
Paper ID	**Paper Title**	**Authors**
187	Characterisation of Data Augmentation Techniques using Visualisation	Kin Wai Lee and Renee Ka Yin Chin
18	Long-Term Forecast of Emergency Demand Using EMS Big Data and Population Estimates by Age	Masaki Kaneda, Sinan Chen, Masahide Nakamura and Sachio Saiki
143	Data Augmentation Approach for Language Identification in Imbalanced Bilingual Code-Mixed Social Media Datasets	Mohd Suhairi Md Suhaimin, Mohd Hanafi Ahmad Hijazi, Ervin Gubin Moung and Mohd Azwan Mohamad Hamza
55	Leveraging Knowledge Graphs for Orphan Entity Allocation in Resume Processing	Shubham Gandhi, Aagam Bakliwal and Yashodhara Haribhakta

Session A2: Smart Agriculture		
Session Chair: Dr. Florence Sia		
Paper ID	**Paper Title**	**Authors**
98	Smart Rooftop Farming Using IoT and Mobile Application in Brunei	Nur Afiqah Natasya Haji Sadikin, Ravi Kumar Patchmuthu and Wida Susanty Haji Suhaili
33	Day-Old Chick Sexing using Convolutional Neural Network (CNN) and Computer Vision	Heidee Soliman-Cuevas and Noel Linsangan
61	Benchmarking CNN Models for Black Pepper Diseases and Malnutrition Prediction	Olivia Ching Hui Chen, Chih How Bong and Nung Kion Lee
52	Hyperparameter Tuning of Convolutional Neural Network for Fresh and Rotten Fruit Recognition	Florence Sia and Nur Shabirah Binti Baco

Session A3: Machine Learning in Agriculture Applications		
Session Chair: Dr. Lorita Angeline		
Paper ID	**Paper Title**	**Authors**
177	Advancing Weed Detection in Agricultural Landscapes using Computer Vision	Bei Ren Tan, Ervin Moung, Muhd. Nur Afnan Uda, Kenneth Tze Kin Teo and Lorita Angeline
45	Nondestructive Freshness Classification System for Cultured Pacific White Shrimp using Electronic Nose and Artificial Neural Network	Jamie Eduardo Rosal, Daryl Ivan Hisola and Sairia Faith Cadiz
47	Detection and Classification of Copra Meat Dryness Using Faster Region-Based Convolutional Neural Network with Inception v2 Architecture	Jamie Eduardo Rosal, Juvy Amor Galindo and Ferhanelfren Mao
141	Grade Classification of Yellowfin Tuna Meat Using F-RCNN with Inception V2 Architecture	Jamie Eduardo Rosal, Daryl Ivan Hisola and May Demabildo

Session B1: Intelligent Control and Robotics

Session Chair: Ir. Dr. Chua Bih Lii

Paper ID	Paper Title	Authors
133	Efficient Robot Following for Enhanced Formation Control in Limited Computing Environments	Pin Jin, Yuhan Wang, Zhuo Zou, Zhongxue Gan and Lizheng Liu
176	Design and Development of a Pipe Climbing Mechanism	Kean Teong Yeoh, Wai Heng Choong, Renee Ka Yin Chin and Bih Lii Chua
184	AGV Path Planning based on Improved Q-learning Optimization	Hao Guo, Min Keng Tan and Kenneth Tze Kin Teo
180	Evolutionary based Control and Optimization of Exothermic Batch Process	Huiyi Xu, Helen Sin Ee Chuo, Min Keng Tan, Chi Huey Ng, Min Yang and Kenneth Tze Kin Teo
178	Autonomous Path Exploration in Unknown Environment Through Deep Reinforcement Learning	Longxin Wei, Kit Guan Lim, Min Keng Tan, Chung Fan Liau, Tianlei Wang and Kenneth Tze Kin Teo

Session B2: Machine Learning in Behavioural Applications

Session Chair: Dr. Lai Po Hung

Paper ID	Paper Title	Authors
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19	Generating Conversation Opportunity for Elderly People Integrating Agent and Conferencing Service	Hiro Okamoto, Sinan Chen, Masahide Nakamura and Sachio Saiki
174	A Mobile-Based Application for Detecting Sleep Deprivation using Deep Learning for University Student	Florence Sia and Lim Jo Ern
118	Addressing Location Dependency in Human Activity Recognition using Channel State Information via 3D- CWT Approach	Fahd Abuhoureyah, Wong Yan Chiew, Ahmad Sadhiqin Mohd Isira and Joon Huang Chuah
60	Spatial Feature Based Violence Detection Using Convolutional Neural Network	Tirthendu Prosad Chakravorty, Mobashra Abeer, Shaiane Prema Baroi, Sristy Roy and Dewan Ziaul Karim

Session B3: Communication Technology

Session Chair: Dr. Aroland M'conie Jilui Kiring

Paper ID	Paper Title	Authors
5	Design Study of a Frequency Divider Using Injection Locking Technique for RF Communication Transceiver	C. W. Hao, M. S. K. Hemel, M. A. S. Bhuiyan, M. B. I. Reaz, T. A. Almohamad and K. N. Minhad
173	IEEE 802.15.4 Signal Strength Evaluation in an Indoor Environment for Positioning Applications	Mohd Syafiq Daniel Wahab and Aroland Kiring
102	Successive Interference Cancellation Approach to Estimated Outage and Coverage Probability for UDN B5G Network	Faizan Qamar, Anand Gachhadar, Syed Hussain Ali Kazmi and Rosilah Hassan
65	Online Machine Learning Approach to Detect and Mitigate Low-Rate DDoS Attacks in SDN-Based Networks	Abdussalam Alashhab, Mohd Soperi Zahid, Mujaheed Abdullahi and Md Siddikur Rahman

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Session Chair: Associate Professor Ir. Dr. Nurmin Bolong		
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42	Concrete Crack Mapping Prediction Formulation Using Stochastic Modelling	Kwong Kok Zee, Lee Foo Wei, Chin Ren Jie, Lim Jee Hock and Chuah Pei Lim
17	Settling Velocity Prediction for Fine Sediment using Generalised Regression Neural Network and Nonlinear Autoregressive Exogenous	Ren Jie Chin, Sai Hin Lai, Lloyd Ling, Ya Qi Yeo, Kar Hui Chan and Wing Son Loh
36	Investigating the Construction Industry Involvement in Smart City Urbanization Development in Malaysia Using PLS-SEM	Wei Heng Ong, Ooi Kuan Tan and Ming Han Lim
88	Tap Settings Optimization in Power Systems: Economic Efficiency Enhancement through Cuckoo Search Algorithm while Ensuring Voltage Stability	Nurul Izzah Raizal, Mohd Helmi Mansor, Ismail Musirin, Sharifah Azwa Shaaya, Saiful Amri Ismail and Nor Laili Ismail
185	Evaluating Energy Efficiency and Sustainability in the Universiti Malaysia Sabah's (UMS) library through 6D Building Information Modelling (BIM)	Nurmin Bolong and Hazler Alebaba

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170	Improve Perturb and Observe Algorithm with Fuzzy Logic	Min Keng Tan, Braindane Owin Moloney, Kit Guan Lim, Soo Siang Yang, Hui Hwang Goh and Kenneth Tze Kin Teo
44	An On-Call Shift for Anaesthetist Rostering Problem (ARP): A Mathematical Model	Mohamad Norizal Abdullah, Masri Ayob, Nasser Sabar, Lam Meng Chun and Liu Chian Yong
46	Knowledge Base Processing Method Based on Text Classification Algorithm	Baisheng Zhong, Sainin Mohd Shamrie and Soo Fun Tan
56	Integrated Optimization Algorithm in Solving Economic Dispatch Problems	Nor Laili Ismail, Ismail Musirin, Nofri Yenita Dahlan, Mohd Helmi Mansor and A.V. Sentilkumar

Session D1: Pattern Classification for Speech and Text Applications		
Session Chair: Associate Professor Dr. Renee Chin		
Paper ID	**Paper Title**	**Authors**
132	A Hybrid Classification Approach For Artificial Speech Detection	Choon Beng Tan, Mohd. Hanafi Ahmad Hijazi and Puteri Nor Ellyza Nohuddin
38	Preliminary Investigation of Balanced Stratified Reduction (BSR) for Imbalanced Datasets	Mohd Hafiz Zakaria, Jafreezal Jaafar and Said Jadid Abdulkadir
152	Social Media User Engagement for Promoting Public Health: Pattern Analysis Using Apriori Approach	Daimler Benz Alebaba, Suaini Sura, Nooralisa Mohd Tuah and Seungwon Lee
99	Deep Bispectral Analysis of Conversational Speech Towards Emotional Climate Recognition	Ghada Alhussein, Mohanad Alkhodari, Ahsan Khandokher and Leontios Hadjileontiadis

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Session Chair: Ts. Dr. Lim Kit Guan		
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53	A Preliminary Investigation into Use of Jaya Algorithm for Area Segmentation of Large Palm Oil Plantations	Weng Kin Lai, Lek Sheng Koay, Lee Choo Tay and Li Li Lim
124	Sharpe Index based Portfolio Optimization using Computational Intelligence	Ahmed Abbas and Kamran Raza
105	Dual Illumination Image Enhancement using Automated MSRCR and Illumination Estimation	Allysa Kate Brillantes, Edwin Sybingco, Argel Bandala, Robert Kerwin Billones, Alexis Fillone and Elmer Dadios
149	Optimal Band Selection In Hyperspectral Images Using Improved K-Means Clustering With Spectral Similarity Measures	Subhash Chander Goud O, T Hitendra Sarma and C Shoba Bindu

Session E1: Machine Learning in Biomedical Applications		
Session Chair: Dr. Rosalyn R. Porle		
Paper ID	**Paper Title**	**Authors**
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ABSTRACTS

5

Design Study of a Frequency Divider Using Injection Locking Technique for RF Communication Transceiver

C. W. Hao, M. S. K. Hemel, M. A. S. Bhuiyan, M. B. I. Reaz, T. A. Almohamad and K. N. Minhad

The increasing variety of radio standards utilized by modern mobile devices necessitates that these devices handle numerous frequency bands. As the frequency range increases, the support for multiple bands creates design issues for frequency synthesizers. The increased frequency range provides the benefit of broader bandwidth and smaller antennas that require less space. An existing frequency synthesizer's performance and range can be enhanced by including frequency dividers. Injection-locked frequency dividers (ILFD) receive the most attention among other frequency dividers due to their better phase noise performance and low-power at high frequencies. This paper presents a divide-by-2 Complementary Metal-Oxide-Semiconductor (CMOS) LC-ILFD with a wide locking range percentage and low power. The proposed CMOS LC-ILFD uses sinusoidal tail current-shaping and cross-coupled topology to reduce phase noise and power consumption. At an injection power of 0 dBm and an injection voltage of 0.6 V, the proposed ILFD has an input frequency locking range of 3.8 GHz to 6.5 GHz (52.43%). Aside from that, the proposed ILFD had a phase noise of −125.97 dBc/Hz at a noise frequency of 1 MHz. The proposed ILFD was realized in 180 nm CMOS process with ADS software and had a power dissipation of 1 mW at a 1V DC supply.

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Settling Velocity Prediction for Fine Sediment using Generalised Regression Neural Network and Nonlinear Autoregressive Exogenous

Ren Jie Chin, Sai Hin Lai, Lloyd Ling, Ya Qi Yeo, Kar Hui Chan and Wing Son Loh

Siltation impacts ecosystem and environment negatively as it will result in water pollution which leads to poor water quality, and subsequently, create harmful effects towards human health. Hence, research on the settling velocity of fine sediment is crucial to be carried out. In this study, Generalised Regression Neural Network (GRNN) and Nonlinear Autoregressive Exogenous (NARX) were used to develop the prediction model for settling velocity of the fine sediment. The input variables are particle size, flow rate, vertical displacement of the particle, maximum depth (dmax) and fraction of actual depth divided by maximum depth (d/dmax), while the output is settling velocity. The developed models were evaluated using a series of statistical analyses. NARX Model IV has shown a better performance in terms of MAE, RMSE and R2, recoded at 0.000331, 0.000439 and 0.9479 respectively.

18

Long-Term Forecast of Emergency Demand Using EMS Big Data and Population Estimates by Age

Masaki Kaneda, Sinan Chen, Masahide Nakamura and Sachio Saiki

In recent years, Japan has been facing a superaging society. The problems of tight emergency medical care and an increase in the number of emergency medical transports have become quite serious. In response to this situation, our research group has been conducting joint research with the Kobe City Fire Department. This study aims to propose and establish a method for medium to long-term prediction of the number of emergency medical transports and to provide an indicator for the strategic deployment of Emergency Medical Services (EMS) and the expansion and contraction of the scale of medical services in the field. This medium to long-term prediction of the number of ambulance transports is achieved by analyzing big data, population data, and future population estimates in each region without machine learning. The proposed method was evaluated in Kobe City, Japan. The results showed that the predicted number of transports is reasonable based on the actual number of transports in the past.

19 **Generating Conversation Opportunity for Elderly People Integrating Agent and Conferencing Service**

Hiro Okamoto, Sinan Chen, Masahide Nakamura and Sachio Saiki

The increase in single-person households and the onset of “COVID-19 frailty” due to COVID-19 have become problems. Our research group focuses on technology support and develops virtual agents using speech recognition technology. In this service, we examined how to promote self-care by having the agent listen to the older person and increase conversation opportunities. However, this service has the problem that it cannot increase opportunities for dialogue with family and friends, which leads to mutual support. In this study, we aim to propose and implement a service called “Easy Video Chat Service” that increases the opportunities for conversation with others through a virtual agent listening service for the elderly person at home.

24 **Proposal an Automated Management Service for Hybrid Meeting Spaces Using Uni-messe and IoT**

Takeshi Yoshida, Sinan Chen, Masahide Nakamura and Sachio Saiki

In recent years, Japan has been actively promoting the concept of a super-smart society, which aims to leverage various scientific technologies to address societal challenges spanning environmental issues, energy management, and disaster preparedness. Within this context, our focus lies on harnessing the potential of Internet of Things (IoT) devices to play a pivotal role in advancing these objectives. The purpose of this paper is to propose an innovative service that streamlines the automatic management of hybrid conferences. To achieve this, we introduce a service coordination platform that leverages the Unified Rule- Based Message Delivery Service (Uni-messe). Our proposed approach involves the initial implementation of a simplified service version, followed by a case study specifically tailored to the conference setting. Throughout our study, we identified two key areas that require further improvement. Firstly, delays arising from communication between devices during the implementation process need to be addressed. Secondly, there is a limitation in operating devices that do not support infrared functionality. In conclusion, our research contributes to advancing super-smart society initiatives by presenting a novel and promising avenue for automating hybrid conferences using IoT and the Uni-messe service coordination platform.

29 **Saturation Degree-based Constructive Heuristic for Master Surgery Scheduling Problem**

Mohamad Khairulamirin Md Razali, Abdul Hadi Abd Rahman, Masri Ayob, Razman Jarmin, Chian Yong Liu, Muhammad Maaya, Azarinah Izaham and Raha Abdul Rahman

Managing operating theatres (OT) is critical in achieving an effective healthcare delivery system. This includes the Master Surgery Scheduling Problem (MSSP), which assigns surgery groups such as medical specialties to OT time slots. Constructive heuristics for the MSSP have been incorporating greedy approaches to generate the solution. However, greedy methods tend to ignore hidden factors and could lead to solution infeasibility. Hence, motivated by other timetabling problems, this study incorporated the Saturation Degree ordering into a ranking-based constructive heuristic for solving the MSSP to improve solution feasibility. The proposed algorithm was benchmarked against the greedy and random approaches, as well as a regret-based approach from the literature and found that it has reduced repair mechanism usage by 57.43%. Furthermore, the ranking-based algorithm avoided infeasible solutions in all runs, whereas the greedy and regret-based approaches failed to do the same when using a greedy repair mechanism. Overall, this work has proved the efficacy of the Saturation Degree ordering in enhancing solution feasibility.

30 Optimization of a Deep Learning Model for E. coli Detection based on Annotation Strategies

Khairul Firdaus Mohd Talib, Muhamad Syahmi Johar, Jia Xin Yap, Choe Peng Leo, Kok Hwa Yu and Kin Sam Yen

Escherichia coli (E. coli) has been widely acknowledged as a pathogenic threat detrimental to human health. One viable option available to the public for E. coli detection is the sample-ready culture-medium, PetrifilmTM. However, the quantification process is hampered by the reliance on manual counting, which remains a challenge. Therefore, this study addresses the limitation by incorporating a deep learning algorithm capable of automating the detection and counting of E. coli. A YOLOv4 model was trained with varying sample sizes, different annotation strategies and class divergence to understand how these variables affect the model's performance and robustness in handling the image variations and inhomogeneity. Results show that stricter annotations had improved the model's mAP up to 10.88% when the model was trained with a smaller dataset and perform better in hold-out testing data with values 4.37%, 5.37% and 4.82% higher in precision, recall and F1-score respectively. Although the performances of the model have no significant difference with the variables when the dataset is larger, as expected, these results confirmed the significance of expert's opinion in data annotation and proper annotation strategy in improving the model performance when the data is scarce. This study contributes to automating E. coli detection strategically and provides insights for effective decision-making in this domain.

32 Enhancing Cancer Classification through the Development of a Fuzzy Gene Selection-Wrapper Plus Method

Mahmood Khalsan, Mu Mu, Eman Salih Al-Shamery, Lee Machado, Michael Opoku Agyeman and Suraj Ajit

Deep Learning (DL) approaches have made substantial advances in developing classification models in most disciplines, in terms of both accuracy and speed. However, analyzing gene expression data for cancer classification remains challenging due to the nature of the complexity of available datasets, which are characterized by high dimensionality (a small number of samples and a large number of features). We developed a new fuzzy gene selection wrapper plus (FGSWP) to select the most significant genes with the goal of reducing the complexity of cancer classification and the dimensionality of the datasets. FGSWP has shown its efficacy by lowering the number of genes and enhancing classifier model performance. Wrapper techniques are not suitable for use with high-dimensional data, hence fuzzy gene selection is used as the initial phase for reducing the number of genes before utilizing wrapper techniques. The accuracy attained in all datasets used ranged from 85.3% to 99.3% when FGSWP and Multilayer Perceptron (MLP) were employed together.

33 Day-Old Chick Sexing using Convolutional Neural Network (CNN) and Computer Vision

Heidee Soliman-Cuevas and Noel Linsangan

As the Research and Development (R&D) Center of Zamboanga Peninsula (ZAMPEN) native chicken in the Philippines, the center supplies ZAMPEN native chicken to growers within the peninsula and its nearby regions. Most growers prefer to buy day-old chicks because of less handling and transfer costs. However, the accuracy rate of R&D staff in classifying day-old chicks thru feather sexing has an average of 55%. Because of this, the center does not sell day-old chicks to growers. This research aims to develop a device that classifies the sex of a day-old ZAMPEN native chick using CNN and computer vision through feather sexing. Two hundred (200) feather images were collected, consisting of 100 females and 1000 males. And 20 no-detection images were added to the data sets. The model was created by sequentially adding layers using VGG-16 architecture. The prototype captures a video of the day-old chick's feathers. Then the video frame is cropped and processed for classification. Thirty (30) day-old chicks were used to test the prototype and got an 83.33% accuracy.

36 Investigating the Construction Industry Involvement in Smart City Urbanization Development in Malaysia Using PLS-SEM

Wei Heng Ong, Ooi Kuan Tan and Ming Han Lim

The Malaysian Government has been developing smart cities progressively since the 1990s. However, the urbanization development in Malaysia has been delayed since the announcement of Vision 2020. It is undeniable that the construction industry plays an important role in smart city urbanization development. As such, the aim of this study is to investigate the perspective of the construction industry involvement in Malaysia in developing smart cities urbanization. Quantitative study and Partial Least Square-Structural Equation Modelling (PLS-SEM) are used for data collection and data analysis. The results revealed that the construction industry player's readiness is highly perceived compared to awareness and preparedness. In conclusion, the construction players are ready to be involved in smart city urbanization development. However, in order to expedite the overall progress of smart city urbanization development in Malaysia it is crucial for the government to implement rules and regulations so that construction industry players familiarize the procedures.

38 Preliminary Investigation of Balanced Stratified Reduction (BSR) for Imbalanced Datasets

Mohd Hafiz Zakaria, Jafreezal Jaafar and Said Jadid Abdulkadir

The prevalence of imbalanced datasets in machine learning poses significant challenges, often leading to models with suboptimal performance, especially in recognizing underrepresented classes. This paper introduces a novel technique, Balanced Stratified Reduction (BSR), aiming to address these challenges by optimizing the sampling process. BSR utilizes horizontal stratification uniquely, drawing inspiration from the quintessence of boxplots. Preliminary results, based on two medical datasets - PIMA Indian Diabetes and Haberman's Survival, showcase BSR's potential in not only managing the class imbalance but also in retaining crucial information from the majority class. The paper outlines the foundational principles of BSR, the motivation behind its inception, a detailed experimental setup for its broader application, and preliminary findings. While the initial outcomes are promising, comprehensive evaluation and application across diverse datasets remain a focal point for future work. BSR's approach, grounded in its methodological rigor, holds promise for more effective handling of imbalanced datasets in real-world scenarios.

39 Cardiovascular Disease Risk in Type 2 Diabetes Mellitus Prediction Model Development using Machine Learning

Ooi Ting Kee, Harmiza Harun, Norlaila Mustafa, Nor Azian Abdul Murad, Siok Fong Chin, Rosmina Jaafar, Hamat Hamdi Che Hassan, Mohd Zubir Suboh and Noraidatulakma Abdullah

Type 2 diabetes mellitus patients have a relatively higher risk of developing cardiovascular disease compared to non-diabetic individuals due to other microvascular complications. A prediction model is necessary to reduce the risk of cardiovascular disease development and the economic burden due to the treatment costs. This study has developed a cardiovascular disease risk prediction model with participants recruited from Endocrine and Cardiology Clinic in Hospital Canselor Tuanku Muhriz (HCTM). After ranking the 24 features using ANOVA, several classifiers were trained with 80:20 data split and 10-fold cross validation using the organized data. A neural networks model with 97.5% accuracy, 97.22% F1 score, and AUC of 0.9979 was selected. A graphical user interface was also developed to provide a user-friendly platform to run the prediction model. The prediction model developed in this study has a high accuracy and precision even though it is trained with a relatively small data size. Prediction models using machine learning should be introduced to the medical settings to assist in the development of cardiovascular complications among diabetes patients.

41 A Smartphone-Based IoT System to Monitor Driving Behaviors by Using a Machine Learning Classifier

Chi-Chung Cheung, Chun-Ming Cheung and Chi-Wang Tong

Traffic accidents cause great casualties and property losses all over the world. Thus, traffic safety is one of the very important topics in smart cities. One of the major causes of traffic accidents is bad driving behaviors. This paper proposes a smartphone-based IoT (Internet of Things) system to monitor driving behaviors by using a machine learning classifier. In this system, a smartphone is put into a car near the driver. A cloud server gets data from accelerators and GPS (Global Positioning System) sensors in the smartphone through a 4G/5G network. In the cloud server, an SVM (Support Vector Machine) classifier and a GPS speed-detecting algorithm are installed to identify abnormal driving behaviors and the instantaneous speed of the car. A user performance report is generated at the end of a journey. The report shows abnormal driving behaviors during the journey and information when the car is over the speed limit. We carried out some experiments and we found that the system can identify different abnormal driving behaviors and driving speed properly. Moreover, the system generated user performance reports properly.

42 Concrete Crack Mapping Prediction Formulation Using Stochastic Modelling

Kwong Kok Zee, Lee Foo Wei, Chin Ren Jie, Lim Jee Hock and Chuah Pei Lim

Non-destructive testing (NDT) is a highly valuable technique for assessing the properties of materials and structures without causing any harm. However, the crack mapping model, which plays a critical role in identifying concrete defects, is limited due to its immature methodology. This aim of the study is to create an advanced 3-dimensional model to predict the crack mapping that integrates cutting-edge stochastic processes. To achieve this, the study employed the Delta method and ABAQUS simulation to simulate propagation of elastic waves in concrete accurately. The proposed model for crack mapping is utilizing interpolation of ellipse-based and beta reflection methods to analyze the concrete cross-sections and concrete surface. The mapping of the surface crack provided comprehensive insights by precisely locating cracks and providing variance information through the beta value. The simulation results demonstrated a firm agreement with theoretical samples, considering the heterogeneous properties of concrete. The model exhibited exceptional reliability in detecting concrete flaws, even when confronted with randomly distributed engineering properties. This study presents an innovative formulation for stochastic modeling in crack mapping prediction, offering significantly improved accuracy and reducing the number of NDT iterations required. It represents a remarkable advancement in the efficient and dependable detection of cracks in concrete structures.

43 Driver-Drowsiness Detection System using Deep Learning (CNN)

Firman Ridwan and Po Hung Lai

Drowsiness and fatigue of drivers are amongst the significant causes of road accidents. Every year, this factor increases the amounts of deaths and fatalities globally. When drivers are drowsy or fatigued, the frequency of yawning is different from those in the normal state. This behavior can determine whether the drivers are fatigued or not. It's critical to use technologies to create and build systems that can detect and monitor drivers' levels of attention throughout the driving process, whether they're alert or sleepy. In this study, A high-precision artificial intelligence model was developed using deep learning to detect driver drowsiness during driving to enhance road safety statistics. The model was trained using a dataset containing pictures of people yawning and blinking. The model is then integrated with mobile applications for ease of use with smartphones for drowsiness detection. The application includes authentication, camera stream, trip history, trip statistics, alarm and notification, and emergency modules. Similar systems proposed by prior researchers using hardware devices such as webcam, smartwatch, and many more to predict drowsiness. The results achieved model's accuracy ranges from 62-87%, depending on the frames input from the camera stream and device performance. The mAP and the average recall of the model were 0.55 and 0.662, respectively. The testing and evaluation phase is divided into three parts: unit testing, integration testing, and user acceptance testing. The results of unit testing and integration testing indicate that the application is working as intended, with high accuracy in detecting driver drowsiness. User acceptance testing is done using the System Usability Scale questionnaire, which shows that the application is perceived to be easy to use, effective, and satisfactory. The proposed system is expected to reduce the statistics of road accidents by detecting drowsy drivers during their driving trips, and it is widely and easily used by road drivers.

44 An On-Call Shift for Anaesthetist Rostering Problem (ARP): A Mathematical Model

Mohamad Norizal Abdullah, Masri Ayob, Nasser Sabar, Lam Meng Chun and Liu Chian Yong

This work dealt with a real-world Anaesthetist Rostering Problem (ARP) for an on-call shift. An on-call shift for an anaesthetist had already been resolved under the physician s rostering problem. However, in their work, each individual can be assigned to only one place throughout the daily on-call shift. In addition, no consecutive days are rostered for the on-call shift, and each level of preference for the on-call shift is excluded from the study. This scenario is irrelevant to the real-world ARP of an on-call shift at Hospital Canselor Tuanku Muhriz (HCTM) in Malaysia, as an anaesthetist is rostered for multiple places of the on-call shifts daily. Also, they can be rostered on consecutive days for on-call shifts, and each anaesthetist will be rostered depending on their preference level for the on-call shift. Therefore, this work proposes a new mathematical formulation with constraints, parameters, and an evaluation function. We utilise Mixed integer programming to formulate and solve the model with IBM ILOG CPLEX Optimization Studio. The quality of the solution generated by our model is measured using our proposed evaluation function to minimise the violation of constraints. A case study of real-world data from the HCTM was run and tested to validate the model. The result shows that a new model can produce a better optimal solution, whilst the current solution methodology at HCTM is unable to do.

45 Nondestructive Freshness Classification System for Cultured Pacific White Shrimp using Electronic Nose and Artificial Neural Network

Jamie Eduardo Rosal, Daryl Ivan Hisola and Sairia Faith Cadiz

The popularity of Pacific white shrimp (PWS) (Litopenaeus vannamei) has grown significantly over time due to its taste and nutritional value. However, ensuring its freshness has become a significant concern due to the subjective methods used by vendors and assessors. In order to address this concern, an electronic nose system has been developed. It uses an array of MQ 135 sensors to detect levels of carbon dioxide (CO2) levels and ammonium (NH4+) and MQ 137 for ammonia (NH3) to classify the freshness of PWS. In order to examine the changes of the PWS at 2 °C storage conditions, measurements using the developed system were taken at a 12-hour time interval. The researchers use the Artificial Neural Network, specifically the Multilayer Perceptron, to develop a classification model. The system obtained 92% accuracy, 92% recall, and 92% precision. The average cross-validation score was 0.927, with a standard deviation of 0.075. The results from the performance evaluation indicate its reliability and accuracy in classifying the freshness of cultured PWS.

46 Knowledge Base Processing Method Based on Text Classification Algorithm

Baisheng Zhong, Sainin Mohd Shamrie and Soo Fun Tan

The text classification algorithm's knowledge base processing method utilizes existing data from the knowledge base to guide the construction and training of the classification model. In practical application, the knowledge base processing method has been prove to have a good performance in text classification tasks. The utilization of knowledge base processing method in text classification has led to an average accuracy improvement of more than 17%. Furthermore, this method significantly reduces labeling costs by approximately 70% compared to traditional approaches. Recently, knowledge base processing methods have been widely used in supporting business applications, social media analysis and other fields. This paper proposes a knowledge base method to establish a feature model related to domain speciality and combine it with traditional text classification algorithm, so as to optimize the training and reasoning process of the classification model and improve the accuracy of classification effect. Lastly, we suggested strategies to overcome the shortcoming of the knowledge base method in improving the construction and training of the classification model.

47 Detection and Classification of Copra Meat Dryness Using Faster Region-Based Convolutional Neural Network with Inception v2 Architecture

Jamie Eduardo Rosal, Juvy Amor Galindo and Ferhanelfren Mao

Sun Dried coconut meat, also known as Copra is used mainly on coconut oil extraction and its by-products for livestock use. The grade of copra is set by the Philippine National Standard for Copra and one of the criteria for the grading/classification is dryness of the copra meat as indicated by the meat color. This study investigates the use of Faster Region-Based Convolutional Neural Network with Inception v2 model in detecting and classifying the level of dryness of copra images as either Optimally Dry, Under-Dry or Over-Dried levels of copra meat. The researchers trained the model and tested it using a validation set which yielded an accuracy rate of 90% for Under Dry, 92% for Optimally Dry copra and 81% for Over Dry, with an overall accuracy rate of 87.67%.

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U-Net Segmentation of Ultra-Widefield Retinal Fundus Images for Retinal Vein Occlusion Associated Lesion Recognition

Ivy Siaw Yin Ong, Lik Thai Lim, Muhammad Hamdi Mahmood and Nung Kion Lee

Inspection of fundus images can identify haemorrhages and cotton wool spots associated with Retinal Vein Occlusion (RVO) disease. Detection of the lesion in fundus images using a computer can aid in early interventions. Previous studies have employed image-processing techniques and feature engineering approaches to identify features from regular images and construct machine learning models. There are limited studies on using Ultra-widefield (UWF) fundus images for machine learning owing to the lack of gold-standard datasets. In addition, it investigates the efficacy of prediction models trained with regular images in predicting RVO symptoms in UWF images. This study employed a deep learning approach to detect RVO lesions and subsequently used them to construct a classifier. We leveraged regular fundus images for lesion segmentation due to the limited availability of public UWF datasets and compared their effectiveness with a segmentation model trained solely on UWF images. Our results found that the segmentation model trained on regular fundus images is less effective in detecting haemorrhages and cotton wool spots in UWF images. Finally, we found that the lesion regions work perfectly in building a classifier that can discriminate between RVO and non-RVO fundus images.

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Driver Maneuver Classification Based on Multivariate Fuzzy Time Series

Omid Orang, Felipe A. R. da Silva, Petrônio Cândido de Lima E Silva, Pedro H. S. S. Barros, Heitor S. Ramos and Frederico Gadelha Guimarães

Driver behavior classification has become an increasingly important application due to the high number of vehicle accidents on the roads. Accordingly, a myriad of classification approaches have been proposed in the literature to distinguish between normal and aggressive driver behaviors. Despite the frequent utilization of machine learning and deep learning approaches, the lack of interpretability is still a serious concern in this domain. In order to address this issue, this paper introduces an interpretable rule-based model called Classification by Multivariate Fuzzy Time Series (CMVFTS). The proposed model employs the fuzzy time series approach, commonly used in time series forecasting, to find classification rules from the training data. The experimental results show the effectiveness of our proposed method in terms of parsimony, and performance metrics on two different datasets available in the literature.

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Hyperparameter Tuning of Convolutional Neural Network for Fresh and Rotten Fruit Recognition

Florence Sia and Nur Shabirah Binti Baco

The freshness of fruits is important in making sure good quality of fruits can be provided to consumers. Manually classifying fruits based on the characteristics of fruits by hand and eyes can be time consuming and unreliable. Convolutional Neural Network (CNN) is the most common deep learning method that has been exploited to classify the freshness of fruits through processing the images of fruits. The classification effectiveness of the CNN is highly depending on its hyperparameter. However, the hyperparameter setting of CNN method has not yet been tuned under diverse values in recognizing the fresh and rotten fruits. In this work, the hyperparameter of CNN is tuned to identify the best setting that can effectively recognize the fresh and rotten fruits particularly orange, apple, and banana. These including the number of epoch, batch size, learning rate, and optimizer with respect to ReLU and Sigmoid activation function. The experiment results show that the hyperparameter tuned CNN model achieved the highest classification accuracy of 99.04%, on real world dataset. Hence, this indicates that the hyperparameter tuned CNN model is capable to recognize the fresh and rotten fruits well.

53 A Preliminary Investigation into Use of Jaya Algorithm for Area Segmentation of Large Palm Oil Plantations

Weng Kin Lai, Lek Sheng Koay, Lee Choo Tay and Li Li Lim

The production of palm oil on a commercial scale is labour intensive with many of its processes handled by humans. In some countries, there can be as many as 500,000 plantation workers in the palm oil sector as the plantations are usually large. However, such dependence on humans for low skills manual work has led to many problems. Unmanned aerial vehicles (UAVs) have been seen as a possible alternative to support some of the processes that require low skills in the palm oil industry. However, the flying time of the UAVs is finite and hence it is important to maximize the number of palm trees that each UAV can service. This paper proposes the segmentation of large palm oil estates into smaller areas to be modeled as a bin packing problem with the Jaya Algorithm. The resultant segmented areas would have an optimal number of palm trees that can be comfortably serviced by the UAV. Good results were achieved when tested on several datasets especially when compared to those computed by human experts.

55 Leveraging Knowledge Graphs for Orphan Entity Allocation in Resume Processing

Shubham Gandhi, Aagam Bakliwal and Yashodhara Haribhakta

Significant challenges are posed in talent acquisition and recruitment by processing and analyzing unstructured data, particularly resumes. This research presents a novel approach for orphan entity allocation in resume processing using knowledge graphs. Techniques of association mining, concept extraction, external knowledge linking, named entity recognition, and knowledge graph construction are integrated into our pipeline. By leveraging these techniques, the aim is to automate and enhance the efficiency of the job screening process by successfully bucketing orphan entities within resumes. This allows for more effective matching between candidates and job positions, streamlining the resume screening process, and enhancing the accuracy of candidate-job matching. The approach's exceptional effectiveness and resilience are highlighted through extensive experimentation and evaluation, ensuring that alternative measures can be relied upon for seamless processing and orphan entity allocation in case of any component failure. The capabilities of knowledge graphs in generating valuable insights through intelligent information extraction and representation, specifically in the domain of categorizing.

56 Integrated Optimization Algorithm in Solving Economic Dispatch Problems

Nor Laili Ismail, Ismail Musirin, Nofri Yenita Dahlan, Mohd Helmi Mansor and A.V. Sentilkumar

The utilization of conservative fossil fuels in power generation has played a significant role in driving economic growth, but it has also resulted in adverse consequences towards environmental impacts. This study proposed Multi-objective Hybrid Evolutionary Programming-Barnacles Mating Optimization as a solution to address the Combined Economic Environmental Dispatch problem by weighted-sum method implementation. The bi-objective function are the minimizing of the total generation cost and total emission have been optimized simultaneously. The performance of the algorithm is evaluated on Reliability Test System IEEE 57-Bus consisting of 7 generating units that consider ramp rate limits generator constraint. The proposed algorithm has been compared with the existing techniques, Multi-objective Barnacles Mating Optimizer and Multiobjective Evolutionary Programming. The results reveal that MOHEBMO generates superior and consistent solutions.

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Features Extraction Technique Analysis of EEG Signal for Motor Imagery Classification

Fouziah Md Yassin, Norita Md Norwawi, Nor Azila Noh, Afishah Alias and Sofina Tamam

For the daily life application of BCI, any assumptions could be violated during the practical test, especially with the small number of channels. Multiple electroencephalogram (EEG) channels could have high accuracy but are not practical for daily life usage compared to a single-channel EEG. However, the single-channel EEG signal has limited sources to extract informative features. Therefore, the aim of the study is to analyze the significant impact of different feature extraction techniques on single EEG channel classification performance. The BCI competition III (IVa) dataset is used for this purpose. Time-frequency domain (E1), and time-domain feature extraction techniques (E2) as well as the combination of both techniques (E3) have been considered to extract the relevant features set from the EEG signals for MI tasks classification. Theclassification accuracy was obtained with two classifiers: Support Vector Machine (SVM) and Logistic Regression (LR). The result shows that there was a significant difference in classification accuracy between E1 and E3. The C3 channel in E3 had the highest accuracy (87.1%) when SVM as the classifier. The proposed approach improved the classification accuracy of AF4 by up to 70% and 70.4% by using SVM and LR, respectively, which is considered acceptable for usage in a BCI system. This implies that MI tasks can be detected with a single-channel EEG by using the proposed method even if the channel is located on the forehead.

60

Spatial Feature Based Violence Detection Using Convolutional Neural Network

Tirthendu Prosad Chakravorty, Mobashra Abeer, Shaiane Prema Baroi, Sristy Roy and Dewan Ziaul Karim

In the past decade, surveillance cameras have become a necessary integration for security measures in all types of localities. The omnipresence of these devices has substantially aided in tackling violent criminal activities. However, human error and biased judgment often result in delayed response and erroneous detection. In larger systems, continuous manual monitoring has become a cumbersome task. Therefore, automated recognition of aggressive activities in surveillance systems can enhance the remote monitoring experience and increase the preciseness of response. Previous experiments on various deep-learning techniques and Convolutional Neural Networks (CNN) tackled the challenge by identifying potential violent activities in real-time. The aim of this research is to benefit from reduced computational cost while maintaining optimality for practical implementation in real life. In this study, a lightweight yet highly effective CNN model has been proposed that can classify violent and non-violent behavior in has undergone robust tuning and training and is capable of accurately extracting frame-level features. It was then evaluated conclusively on a combination of multiple benchmark datasets to see how well each of them performed. In conclusion, the proposed model has achieved an outstanding test accuracy of 99.6% and outperforms other popular CNN architectures by great margins.

61 Benchmarking CNN Models for Black Pepper Diseases and Malnutrition Prediction

Olivia Ching Hui Chen, Chih How Bong and Nung Kion Lee

Black Pepper (Piper nigrum L.) is one of the most important commodities in Southeast Asia. Like other plants, black pepper plants are exposed to various diseases and growth issues. Automated recognition of plant diseases and nutrient deficiencies is important with the availability of mobile devices. This paper aims to provide a benchmark for CNN models in learning the symptoms related to black pepper disease or malnutrition indicated on the leaves. Samples of black pepper leaf for 11 diseases and nutrient deficiencies were collected from farms in Sarawak. A total of 1,043 images of the samples were taken in a controlled environment. Augmentation was performed to increase the number of samples and to generate variation. Five deep-learning neural network architectures were selected for the modelling of the classification task. The results showed that state-of-the-art CNNs EfficientNet-B0 (0.88 accuracies), MobileNet-v2 (0.88 accuracies), ResNet-V2-50 (0.86 accuracies), DenseNet121 (0.85 accuracies) and a customized CNN (0.85 accuracies), can act as benchmarks for black pepper disease or malnutrition diagnosis via the leaves. The models have the potential to be used for early detection and intervention for black pepper plant management.

65 Online Machine Learning Approach to Detect and Mitigate Low-Rate DDoS Attacks in SDN-Based Networks

Abdussalam Alashhab, Mohd Soperi Zahid, Mohamed Alashhab and Shehabuldin Alashhab

Software Defined Networking (SDN) technology provides rapid configuration, scalability, and management through its dynamic, programmable architecture that outperforms traditional network architecture with limitations on scalability and management. However, the threat of Distributed Denial of Service (DDoS) attacks remains difficult to detect and threatens traditional and SDN-based networks. Fortunately, Machine Learning (ML) and Deep Learning (DL) technologies along with SDN have proven to have a superior potential to deal with these threats effectively. However, most of the previous studies focused on resolving high-rate DDoS attacks, and only a few dealt with the detection of Low-rate DDoS attacks that are difficult to detect due to their similarity to legitimate traffic. In addition, these studies do not utilize up to date datasets that contain the new features. To address this issue, we propose an online machine learning model that utilizes Stochastic Gradient Descent (SGD) optimizer and Explainable Boosting Machine (EBM) classifier to detect LDDoS attacks in SDN-based networks. Our model is designed to process large amounts of network traffic data in real-time and updates the model parameters incrementally to continually train the model on expected DDoS attacks, as the attack may change and appear differently. We evaluated the proposed approach in an SDN-simulated environment using Mininet and the Ryu controller. Our experimental results show that the proposed EBM model achieves high accuracy and outperforms existing methods, with 99% accuracy on the training data. The proposed system effectively counters LDDoS attacks and adapts to future mutations and zero-day DDoS attacks.

88 Tap Settings Optimization in Power Systems: Economic Efficiency Enhancement through Cuckoo Search Algorithm while Ensuring Voltage Stability

Nurul Izzah Raizal, Mohd Helmi Mansor, Ismail Musirin, Sharifah Azwa Shaaya, Saiful Amri Ismail and Nor Laili Ismail

This paper presents an approach to enhance the economic efficiency of power systems through tap settings optimization using Cuckoo Search Algorithm (CSA), while ensuring voltage stability. With the escalating demand for electrical power, power system networks face challenges such as voltage decay, increased current flows, and energy losses. Reactive power planning, including tap settings optimization, plays a crucial role in addressing these challenges and optimizing system performance. Specifically, this study focuses on the role of on-load tap-changing transformers (OLTCs) in regulating voltage levels without interrupting the power supply. CSA is employed as an optimization technique due to its effectiveness in handling complex and nonlinear optimization problems. The objectives of the optimization process include minimizing active power losses and generation costs while maintaining voltage stability. The IEEE 26-Bus Reliability Test System (RTS) is used as a test system to demonstrate the implementation and effectiveness of the proposed approach. It has been found that CSA successfully improved the power system operation in terms of reduced active losses and generation costs compared to the non-optimal solution obtained from the power flow analysis. The results contribute to enhancing the economic efficiency of power systems and provide valuable findings for power system planning and operation.

91 Enhancing Review Authenticity using Transformers: Web Extension for Detecting AI-generated Fake Reviews vs Human-written Feedback

Ishita Choudhary, Nitika Tyagi, Pratham Taneja and Ronak Bhatia

The importance of the online review system is growing along with the significant increase in internet users. The reliability of online reviews is crucial for businesses since they have a significant influence on their reputation and revenue. It is essential in influencing how people see a good or service, as they are the ones through which customers share their first-hand experience. This study suggests a flexible and user-friendly web plugin while shedding light on the most effective method for locating and eliminating genuine evaluations. The web plugin will have a significant impact on customers and help them form better opinions about a product or service. A supervised learning model is used while deploying the proposed plugin. The user just has to enable the plugin first. The dataset is then retrieved using web scraping tools. Further, in order to extract sound characteristics from the data, it is examined and deconstructed using Natural Language Processing methods. Later predictions are made on the data. Three models namely- BERT, DeBERTa, and XLNet are used for review classification. Based on the experimental results of the study, DeBERTa has a dataset accuracy of 98%, which is the maximum out of all the three models used. The major goal of this project is to develop a fake survey filtering system that will give clients more trustworthy data and prevent enterprises from losing money dramatically.

95 IoT Based Novel Approach For Remote Patient Pulse Rate Monitoring and Stroke Prediction using Machine Learning

Prajakta Musale, Arya Pathak, Pranav Patel, Aarushi Pathak, Revati Pathak, Ameya Pathak and Rukmoddin Patel

In recent years, the advancement of Internet of Things (IoT) technologies has revolutionized various domains, including healthcare. Remote patient monitoring is an emerging field that allows healthcare professionals to monitor vital signs of patients remotely, ensuring timely intervention and improved healthcare outcomes. This research paper presents a system that combines the ESP32 microcontroller, an Express MVC website, and a web API to enable remote pulse monitoring. The ESP32 collects pulse data and sends HTTP requests to a web API, which then responds with live data to be displayed on the Express MVC website. Additionally, based on specific response codes from the web API, the ESP32 triggers a WhatsApp bot to notify healthcare professionals. The proposed system demonstrates the feasibility and potential for remote pulse monitoring using readily available IoT components.

98 Smart Rooftop Farming Using IoT and Mobile Application in Brunei

Nur Afiqah Natasya Haji Sadikin, Ravi Kumar Patchmuthu and Wida Susanty Haji Suhaili

Climate Change is significantly a concern to the agriculture industry as its exposure and vulnerability have an adverse impact on the agricultural output. The development and growth of agricultural sectors will contribute to the Brunei Vision 2035 aim of achieving a dynamic and sustainable economy. However, because of the inability to adapt to climate change, growth has begun to slow down in recent years. Thus, cultivated crops are adversely impacted and destroyed during wet seasons. So, to prevent this issue, a small-scale project is devised to help save crops from heavy rains and increased temperatures. By applying this technological approach can automate the weather-controlling process to help small-scale farmers or individuals efficiently manage the farm, increase production capabilities, support a sustainable economy, and plan future tasks accordingly. An Internet of Things (IoT) research prototype was developed to simulate rooftop farming and automate weather monitoring and controlling. This includes implementing a web application where the data received from the wireless sensor is stored in the database.

99 Deep Bispectral Analysis of Conversational Speech Towards Emotional Climate Recognition

Ghada Alhussein, Mohanad Alkhodari, Ahsan Khandokher and Leontios Hadjileontiadis

Peers' conversational speech plays a significant role in shaping the emotional climate (EC) during interactions. Machine-based recognition of EC provides insights into the emotional perception of conversations by both peers and external observers. In this paper, we pro- pose DeepBispec, a novel approach for EC recognition using deep bispectral analysis. DeepBispec applies windowed bispectral analysis to the 1D conversational speech signal. By capturing higher-order spectral correlations, the bispectrum magnifies the nonlinear characteristics present in speech signals. The estimated 2D-bispectrum magnitude contours, representing these interactions, are transformed into colored images and fed into a convolutional neural network (CNN). The CNN learns deep features from the bispectrum magnitude contours, enabling it to predict the valence (V) and arousal (A) labels associated with the EC. Evaluating DeepBispec on the K- EmoCon dataset using 10-fold cross-validation, we achieve an accuracy of 0.789 (A)/0.771 (V), an F1 score of 0.850 (A)/0.836 (V), and an area under the curve (AUC) of 0.812 (A)/0.788 (V). These results surpass existing benchmarks, demonstrating the effectiveness of bispectrum in capturing nonlinear characteristics and improving EC recognition. DeepBispec introduces an innovative approach to analyzing conversational speech for enhanced EC recognition. By leveraging deep bispectral analysis and CNN, it uncovers the higher-order spectral correlations and nonlinear dynamics of speech signals. This contributes to a deeper understanding of emotional dynamics in conversations and provides valuable insights into EC perception.

100 Improved Machine Learning Algorithm for Heart Disease Prediction Based on Hyperparameter Tuning

Eka Pandu Cynthia, Suzani Binti Mohamad Samuri, Wang Shir Li, Edi Ismanto, Liza Afriyanti and M. Imam Arifandy

Today, one of the leading causes of death worldwide is heart disease. A significant challenge in the field of clinical data analysis is the prediction of cardiovascular disease. Machine learning (ML) has been shown to be effective in assisting prediction and decision-making due to the enormous amount of data generated by the healthcare sector. Numerous studies have only partially examined the use of machine learning techniques to predict heart disease. In this study, we present and evaluate a method for hyper-parameter tuning that makes use of GridSearchCV and RandomizedSearchCV to improve the precision of machine learning algorithm models. We also evaluate important features that are consistent with the effectiveness of machine learning models in foretelling the development of cardiovascular disease. The prediction model is tested using a variety of classification techniques, as well as various hyper-parameter tuning procedures. We were able to predict heart disease at higher performance levels with 88% accuracy rates for Logistic Regression (LR) models and 86% accuracy rates for Random Forest (RF) models.

102 Successive Interference Cancellation Approach to Estimated Outage and Coverage Probability for UDN B5G Network

Faizan Qamar, Anand Gachhadar, Syed Hussain Ali Kazmi and Rosilah Hassan

The rapid evolution of wireless communication technologies has led to the emergence of Ultra-Dense Networks (UDNs) in Beyond 5G (B5G) systems, providing unprecedented connectivity and capacity. However, the dense deployment of base stations in UDNs results in severe interference, leading to considerable performance challenges. To tackle this issue, the Successive Interference Cancellation (SIC) approach has gained attention as a promising technique to enhance system performance. This research article explores the potential of SIC implementation in 5G UDN. The primary contribution of this work is summarized as follows. Firstly, an improved SIC technique is developed to validate the theoretical study of SIC in a multi-tier 5G UDN. This technique enhances the accuracy of outage probability and coverage probability calculations by employing a stochastic geometry model that accurately represents the real-world scenario, considering the random distribution of both users and base stations within the UDN. Secondly, numerical simulations are conducted to demonstrate the effectiveness of the proposed SIC technique, surpassing traditional methods. The simulation results are compared with Zero Forcing (ZF) to assess the validity and applicability of the concept and validate the theoretical findings. This research contributes to advancing the understanding and practical implementation of SIC in UDN, paving the way for improved network performance and capacity in future wireless communication systems.

105 Dual Illumination Image Enhancement using Automated MSRCR and Illumination Estimation

Allysa Kate Brillantes, Edwin Sybingco, Argel Bandala, Robert Kerwin Billones, Alexis Fillone and Elmer Dadios

Images taken in low-light environments like nighttime or cloudy weather are not conducive to monitoring and fail to fulfill the requirements of applications such as image processing and computer vision. This paper focuses on improving a dual illumination image enhancement algorithm to achieve better image quality and reduce the processing time of producing an enhanced image. The underexposed correction image was produced using Automated Multiscale Retinex Color Restoration while the overexposed correction image was produced using illumination estimation, the corrected images were combined to generate a better-quality image. The system was assessed using the metrics: BRISQUE, NIQE, MDM, and CEIQ, and achieved a BRISQUE value of 18.628, NIQE value of 1.744, MDM value of 0.968, and CEIQ value of 3.615.

110 Delay Optimization of IoT-Edge Computing in Smart Grid using Deep Reinforcement Learning

Fauzun Asuhaimi, Muhammad Akmal Jafri, Ahmad Fikri Dahari and Mohd Khairil Mohd Hatta

Internet of Things (IoT) technology is being increasingly used in the smart grid to enable real-time monitoring, control, and optimization of power systems. With the Internet as processing centre for IoT, various physical devices such as sensors, meters, and controllers, it enables them to exchange information and interact among each other. In an IoT system, edge computing provides a decentralized computing environment where data can be processed close to the source, reducing latency and network traffic. By integrating IoT edge computing, the smart grid system can collect real-time data on grid operations and use this information to optimize its performance. However, the large volume of data generated by IoT devices in a smart grid system can cause delays in processing and decision-making. To overcome this challenge, delay optimization techniques such as workload allocation is needed to ensure that the smart grid system can quickly and accurately process the data it receives from IoT devices and make decisions based on that data. By using deep reinforcement learning (DRL), we can implement and evaluate the proposed method which is the workload allocation technique. DRL algorithms can learn to decide which action is the best based on the situation of the grid, optimizing delay without the knowledge of the system itself. By using edge-computing as proposed technique, it is proven that it can outperform the cloud computing method based on the result from the simulation.

111 **Blockchain-based Anti-Counterfeit Product Identification System**

Yen Xuan Lo and Tan Chye Cheah

In recent years, blockchain technology has emerged as a revolutionary technology with the potential to disrupt traditional business structures and transform the way data is stored and shared. One of the key advantages of blockchain is its ability to provide tamper-proof data, making it an ideal solution for addressing the growing problem of counterfeit goods. This paper presents a practical anticounterfeit product identification system that leverages the unique capabilities of blockchain technology. The proposed system provides a secure and transparent platform for tracking and verifying the authenticity of products across various industries. Through extensive testing and evaluation, it has been demonstrated that this system effectively reduces the prevalence of counterfeit products and increases consumer confidence in the authenticity of their purchases.

113 **Energy Efficiency of IoT-Edge Computing in Smart Grid using Deep Reinforcement Learning**

Fauzun Abdullah Asuhaimi, Ahmad Fikri Dahari, Muhammad Akmal Jafri and Mohd Khairil Mohd Hatta

Smart grids have attracted more and more attention due to the characteristic of itself that provide much more interactive solution comparing from the conventional grid, such as enabling demand side management (DSM) and demand response and so on. In smart grid, Wide Area Networks (WAN) is a part of the largest communication network that provides communication to the energy generation domains such as solar panels. Internet-of-Thing (IoT) can be adopted to provide communication in WAN. However, IoT may suffer in term of quality of services as well as energy efficiency because of how far the data must transmit since WAN cover the largest area. Therefore IoT-Edge Computing can be adopted to process the data nearer to the sources of data generation before transmitting into the cloud services. Energy efficiency in IoT is critical especially when smart grid is considered. Specifically, when a fault occurs in a grid, the sensors and the technologies in the areas affected by the fault will be isolated and have the shortage of power supply. In this paper, we proposed power control method to curb the problem state before. To find the best action, deep reinforcement learning (DRL) is adopted. DRL has the ability to learn make decision in a dynamic environment through a combination of deep learning and reinforcement learning techniques. Simulation results show that with the proposed method, the energy efficiency manage to elevate.

118 **Addressing Location Dependency in Human Activity Recognition using Channel State Information via 3D- CWT Approach**

Fahd Abuhoureyah, Wong Yan Chiew, Ahmad Sadhiqin Mohd Isira and Joon Huang Chuah

This work presents an exceptional approach to address the location dependency challenge in Human Activity Recognition (HAR) using Channel State Information (CSI). HAR using CSI has shown promise in capturing fine-grained motion information; however, the performance of models varies significantly across different locations or positions. To mitigate this limitation, we propose an innovative solution based on 3D Continuous Wavelet Transform (CWT) that simultaneously captures spatial and temporal information. Experimental results demonstrate the effectiveness of the proposed approach in reducing location dependency and improving activity recognition accuracy across diverse environments.

124 Sharpe Index based Portfolio Optimization using Computational Intelligence

Ahmed Abbas and Kamran Raza

Portfolio optimization is a complex problem with multiple objectives, namely maximizing investment returns while simultaneously minimizing variance (risk). Particularly when considering real-time constraints, it becomes a nonlinear problem that can be effectively addressed through the utilization of computational intelligence techniques. This research paper introduces two such techniques, namely Particle Swarm Optimization (PSO) and Genetic Algorithms (GA), for optimizing the portfolio of the Karachi Stock Exchange 30 index. The selection model for the portfolio is based on Markowitz's meanvariance theory, enhanced with floor and ceiling constraints, and considers expected returns and the Sharpe ratio. The results obtained from these computational intelligence techniques are compared with the optimization capabilities of MS Excel (Solver). The findings reveal that PSO outperforms both Solver and GA in terms of achieving superior optimization outcomes.

129 The Development of Simultaneous Congkak Game with Intelligent Agents

Nik Abdul Muhaimin Nik Ahmad Fazlan and Tan Chye Cheah

Congkak is a two-player game of perfect information with two phases, a simultaneous phase and a sequential phase. In this work, several intelligent agents for each phase were implemented to determine that minimax is the best algorithm for the sequential phase of the game. From the agents implemented, the payoff matrix of the game can be determined. It is shown that there is no pure strategy Nash Equilibrium but there exists a mixed strategy Nash Equilibrium of (0, 0, 0.111, 0.111, 0.333, 0.111, 0.333). An agent using this mixed strategy was proven to be more effective than the simultaneous agents trained.

130 Enhancing Multi-Stage Classification of Alzheimer's Disease with Attention Mechanism

Pui Ching Wong, Shahrum Shah Abdullah and Mohd Ibrahim Shapiai

Multi-stage classification of Alzheimer’s disease (AD) refers to classifying the disease into its multiple stages. Aside from a binary classification task that classifies between the normal control (NC) and AD stages only, an additional prodromal stage known as Mild Cognitive Impairment (MCI) is also being classified. MCI is the stage between the healthy subjects known as the NC class, and the patients with heavy symptoms, in the AD class. In other words, MCI subjects only have slight or mild symptoms of Alzheimer’s, thus leading it to be a challenge for detection. Classification models usually perform well in binary classification tasks, but not in multistage classification tasks, due to the faint difference in their features. Thus, this research proposes the incorporation of an attention mechanism into the classification model to increase its multi-stage classification performance. The attention mechanism facilitates the classification task by identifying the important features in MRI images so that the model can better differentiate the multiple classes. The MRI data used in this study is obtained from the Open Access Series of Imaging Studies (OASIS) database. The experimental results show that the attention-incorporated model has achieved an improved classification performance as compared to the normal model without attention. The generalizability of the enhanced model is also improved as observed from the training-classification gap results. Hence, the exceptional performance of the attention mechanism positions it as a solution to boost and enhance multi-stage AD classification.

132 A Hybrid Classification Approach For Artificial Speech Detection

Choon Beng Tan, Mohd. Hanafi Ahmad Hijazi and Puteri Nor Ellyza Nohuddin

The emergence of voice biometrics has revolutionized user authentication methods by delivering enhanced security and convenience, steadily replacing less secure authentication techniques. However, the automatic speaker verification (ASV) systems remained vulnerable to spoofing attacks, especially artificial speech attacks. This is because artificial speech can be generated rapidly and in abundance using state-of-the-art speech synthesis and voice conversion algorithms. Recently, a one-class learning-based countermeasure known as the AIR-ASVspoof was introduced for artificial speech detection, which has proven to be the bestperforming non-fusion system. As AIR-ASVspoof focuses solely on the bona fide class as the target in artificial speech detection, its practicality in a real-world environment may be restricted. The reason for this limitation lies in the fact that bona fide speech can be recorded in different environments, thereby increasing the risk of encountering false negatives. Hence, this paper proposes a hybrid approach to mitigate the issue, named Hybrid AIRASVspoof (HAIR-ASVspoof), by hybridizing end-to-end learning and classic machine learning. In this approach, deep features will be extracted from the dataset using the trained AIRASVspoof model and classified using a classic machine learning model such as Support Vector Machine (SVM). The objectives are: (i) to extract deep features using the AIR-ASVspoof; and (ii) to compare the performance of the AIR-ASVspoof and the proposed hybrid approach. An experiment was conducted to find the appropriate backend classifier for the proposed hybrid approach. Experimental results showed that the proposed approach outperformed the original AIR-ASVspoof, with an Equal Error Rate (EER) of 0.57%.

133 Efficient Robot Following for Enhanced Formation Control in Limited Computing Environments

Pin Jin, Yuhan Wang, Zhuo Zou, Zhongxue Gan and Lizheng Liu

This paper presents our work on achieving robot following using resource-constrained robots without relying on computationally expensive strategies like deep learning. Our system architecture is built upon the e-puck robot platform, which features various hardware components including a Timeof-Flight (ToF) sensor and LEDs. We propose two tracking algorithms: ToF tracking and LED tracking. The ToF tracking algorithm estimates the direction of the leader robot by oscillating the follower robot and collecting ToF readings from both sides. The LED tracking algorithm processes real-time camera frames, and utilizes a PID control mechanism to ensure that the follower robot maintains the desired position relative to the leader. By leveraging the unique capabilities of the e-puck platform, we enable resource-constrained robots to perform complex tasks such as tracking and following without high computational requirements. Our research contributes to the advancement of robotics in resource-constrained settings, opening up new possibilities for the deployment of intelligent and efficient robotic systems.

139 Accuracy Improvement of Object Detection in VVC Coded Video Using YOLO-v7 Features

Takahiro Shindo, Taiju Watanabe, Kein Yamada and Hiroshi Watanabe

With advances in image recognition technology based on deep learning, automatic video analysis by Artificial Intelligence is becoming more widespread. As the amount of video used for image recognition increases, efficient compression methods for such video data are necessary. In general, when the image quality deteriorates due to image encoding, the image recognition accuracy also falls. Therefore, in this paper, we propose a neural-network-based approach to improve image recognition accuracy, especially the object detection accuracy by applying post-processing to the encoded video. Versatile Video Coding (VVC) will be used for the video compression method, since it is the latest video coding method with the best encoding performance. The neural network is trained using the features of YOLO-v7, the latest object detection model. By using VVC as the video coding method and YOLO-v7 as the detection model, high object detection accuracy is achieved even at low bit rates. Experimental results show that the combination of the proposed method and VVC achieves better coding performance than regular VVC in object detection accuracy.

141 **Grade Classification of Yellowfin Tuna Meat Using F-RCNN with Inception V2 Architecture**

Jamie Eduardo Rosal, Daryl Ivan Hisola and May Demabildo

Yellowfin Tuna (Thunnus albacares), holds a significant economic importance as it is globally traded and widely consumed. Given its value, ensuring the quality of yellowfin tuna is vital. In this study, an Object Detection Convolutional Neural Network model F-RCNN with Inception V2 is developed to effectively classify tuna meat quality. Quality grades of the tuna were classified using letter grades: Grade A, Grade B and Grade C. It demonstrated an accuracy of 86.67% for Grade A, a perfect score of 100% for Grade B, and 92.50% for Grade C. Overall, the model achieved an accuracy rate of 92.8% in accurately categorizing the different grades of tuna.

143 **Data Augmentation Approach for Language Identification in Imbalanced Bilingual Code-Mixed Social Media Datasets**

Mohd Suhairi Md Suhaimin, Mohd Hanafi Ahmad Hijazi, Ervin Gubin Moung and Mohd Azwan Mohamad Hamza

Addressing the problem of language identification in code-mixed datasets poses notable challenges due to data scarcity and high confusability in bilingual contexts. These challenges are further amplified by the associated imbalance and noise characteristic of social media data, complicating efforts to optimize performance. This paper introduces an augmentation approach designed to enhance language identification in bilingual code-mixed social media data. By incorporating reverse translation, semantic similarity, and sampling techniques alongside customized preprocessing strategies, our approach offers a comprehensive solution to these complex issues. To evaluate the effectiveness of the proposed approach, experiments were conducted on language identification at both the sentence and word levels. The results demonstrated the potential of the approach in optimizing language identification performance, offering a compelling combination of generation techniques for addressing the challenges of language identification in code-mixed data.

145 **NayaN: A Multi-view Neural Network Approach to Detect Depression**

Sahil Nimsarkar and Rajesh Ingle

The mental health crisis has reached alarming proportions due to a shortage of personnel in the mental healthcare workforce, resulting in inadequate and irregular treatment for patients. This has led to a rise in deaths due to neglect of mental well-being. To address this issue, this research aims to find an affordable and ready-to-deploy service that will assist healthcare workers in identifying mental illnesses in patients at an early stage. The proposed study then aims to find voice analyzing algorithms to detect signs of mental illnesses in real time using innovative feature engineering techniques. It finally aims to alleviate the mental health crisis by providing innovative measures against inadequate and irregular treatment of patients.

149 **Optimal Band Selection In Hyperspectral Images Using Improved K-Means Clustering With Spectral Similarity Measures**

Subhash Chander Goud O, T Hitendra Sarma and C Shoba Bindu

Hyperspectral imaging provides abundant spectral information with hundreds of bands, but selecting an optimal number of bands is crucial for efficient and accurate data analysis. The k-means clustering method is widely used for band selection, but the quality of clustering and efficiency of band selection depends on the similarity measure used. In this paper, we propose an improved version of k-means clustering using spectral similarity measures (SSM) such as Spectral Angle Mapper (SAM), Spectral Information Divergence (SID), and the hybrid measure of SID and SAM (SIDSAM) for optimal band selection. Empirically it is proved that the proposed k-means with spectral similarity measures will identify the best bands and thereby improve the classification accuracy.

152 Social Media User Engagement for Promoting Public Health: Pattern Analysis Using Apriori Approach

Daimler Benz Alebaba, Suaini Sura, Nooralisa Mohd Tuah and Seungwon Lee

User engagement has become an essential aspect of research in technology, marketing, and social media. Measuring and analyzing user engagement has gained significant importance due to its ability to provide valuable insights to assess engagement responses from online users engaged in published content. Previous studies have devised various methods to effectively analyze data, with statistical approaches commonly used as techniques. However, statistical approaches often struggle to effectively handle categorical variables, for which interpretation becomes limited and less informative, also failing to capture the structure and dependencies inherent in categorical data. Therefore, Apriori approach that defines association rules to generate patterns based on user frequent itemset is adapted to identify UGC patterns for user engagement in public health social media. This study aims to generate association rules based on UGC data and identify UGC patterns for user engagement. The frequency of UGC data such as like, link click, share, and comment was analyzed using Apriori approach with support and confidence thresholds. The result shows that 16 association rules were generated based on UGC data. Five with 100%, three with 90%, one with 60%, three with 50%, one with 40%, and three with 30%. It can be concluded that the Apriori approach can be used in identifying the pattern of user engagement on public health social media other than buying and selling of market basket transactions.

154 Internet-of-Things Behavior Monitoring System Based on Wearable Inertial Sensors for Classifying Dairy Cattle Health Using Machine Learning

Zhonghao Shi, Zi'Ang Zhang, Yuanzheng Jia, Jun Li, Xinyue Wang, Yawei Qiu, Jinfeng Miao, Fangyuan Chang, Xiangan Han and Wei Tang

In this work, an Internet-of-Things (IoT) system for monitoring dairy cattle behavior is developed using wearable inertial sensors and machine learning algorithms. A behavior recognition model is established using the K-Nearest Neighbors (KNN) algorithm to monitor feeding and movement behaviors, including standing, lying, walking, resting, feeding, and ruminating, with high accuracy above 80%. Based on the recognized behaviors from leg and collar sensors, a health classification model is further developed using the Support Vector Machine (SVM) machine learning algorithm, achieving an accuracy of up to 70%. By embedding these models into the developed IoT system, online real-time monitoring of dairy cattle's daily behaviors and health score is demonstrated, enabling health status alerting. This work lays the foundation for designing IoT systems for real-time monitoring of dairy cattle behaviors and health status classification towards cost effective livestock farming.

156 Supporting Financial Inclusion with Digital Financial Services: Comparative Analysis of Machine Learning Models

Hui Shan Lee, Kee Seng Kuang, Ping Xin Liew, Wai Mun Har and Choon Wei Low

While Malaysia has made significant progress in promoting financial inclusion, limited access to banking services due to physical proximity and a limited branch network continues to hinder its full realization. Digital financial services can facilitate the promotion of financial inclusion as they offer enhanced accessibility, convenience, and affordability to individuals who face limited availability of traditional financial services. The objective of this research is to examine whether digital financial services can drive financial inclusion in Malaysia by using machine learning models. Using the Global Findex 2021 Database, this study employs supervised machine learning models to predict the roles of digital financial services in influencing financial inclusion. Based on a comparison among the methods in supervised learning (linear regression, logistic regression, decision trees, random forest, support vector machines, gradient boosting, naive Bayes, K-nearest neighbors, and neural networks), the random forest model demonstrates the best performance in using digital financial services factors to predict financial inclusion. The random forest model suggests that making or receiving digital payments, buying something online and making bill payments online using the internet are the most influential factors driving financial inclusion. The implication of this study suggests that governments, financial institutions, and service providers could prioritize these elements to effectively promote financial inclusion. The novelty of this study lies in the use of machine learning models to accurately predict the variables that explain financial inclusion, providing the capability to make precise predictions for new, previously unseen factors based on the knowledge acquired from the training data.

159 Unleashing the Power of Machine Learning: Revolutionizing Early Diagnosis and Prevention of Mental Health Disorder

Chhavi Baliyan, Dr Rajesh Dhumal and Dr Ruchi Gupta

In modern times, mental health issues have become an important concern with far-reaching effects on both individuals and companies. This research paper investigates the impact of geographical location, work environment, gender, and employment status on mental health illness prediction. This study aims to investigate the possible connections between these variables and mental health outcomes, as well as individuals' attitudes towards mental health. This study seeks to identify the strongest factors influencing mental health disorders and attitudes, contributing to our knowledge of the complex mechanisms behind mental well-being. To achieve the objective, various classification models were used, including the Random Forest Classifier, AdaBoost Classifier, Gradient Boost Classifier, XGB Classifier, and a hybrid Stacking Model. The models were trained and evaluated using various metrics to measure their performance. The metrics considered were train and test accuracy, precision, recall, F1- score, ROC curve, and AUC. The metrics mentioned are important indicators of the models' predictive accuracy, ability to distinguish, and overall performance. In this study, we conducted a comparative analysis of various techniques and successfully implemented them. Through our evaluation, we identified the Stacking technique as the most accurate method, achieving a prediction accuracy of 82.27%. This study aims to contribute towards addressing the potential rise of a widespread "mental health epidemic."

165 Semi Supervised Anomaly Detection using PatchCore Auto Encoder

Abhishek P G, Deepan Raj M and Sainarayanan Gopalakrishnan

Anomaly detection is always a challenging problem in the field of computer vision because the number of defective samples is often minimal or nonexistent. This creates a significant challenge in understanding the nuances of an anomalous sample without having seen it. This often remains a cold-start problem as most approaches don't consider anomaly samples, even if they are present in small numbers. The proposed method is an extension of patchcore-based anomaly detection, by taking anomaly samples into consideration. The method extracts locally aware patch features from nominal samples and is stored in a memory bank and then furthermore training the features with an autoencoder to learn the nuances required for reconstruction. Additionally, abnormal samples are included in the process, and stored in the same memory bank. Finally, using the K-Nearest Neighbor, the test samples can be classified there by auto encoder will be used to point out the region of interest for the likelihood of anomaly. The weak supervision of abnormal data samples and autoencoder greatly enhances the significance of the work and can achieve an accuracy of 94% on the MVTEC AD Benchmark (Pill) dataset.

166 Development of Contactless Door Lock System using Text-Dependent Voice Authentication

Ismail Saad, Nurliyana Syahirah Amran, Hazlihan Haris and Min Keng Tan

Electronic door locks are getting more attention for their advantages over conventional mechanical locks, such as do not worry about lost keys. However, majority the electronic locks require physical contact, which does not address virus spread issues as the users need to input a password physically. Thus, this work aims to develop a prototype of voice recognition electronic door lock. The developed system allows the users to unlock the door using voice commands through their smartphones to avoid any physical contact. An Arduino Voice Control mobile application is used as the graphical user interface to allow the users to pronounce the door password and transmit the voice to the door lock system via Bluetooth. If the spoken password is correct, the system will unlock the door. A few tests have been conducted to ensure the functionality of the developed prototype.

168 Optimisation of Photovoltaic Energy Harvesting using Clonal Selection Algorithm

Min Keng Tan, Grace Butiza Joponi, Kit Guan Lim, Ahmad Razani Haron, Chang Yii Chai and Kenneth Tze Kin Teo

The rising demand for renewable energy sources has fueled extensive research in photovoltaic (PV) systems. However, conventional Maximum Power Point Tracking (MPPT) algorithms often encounter challenges when tracking the global maximum power point under non-uniform irradiance conditions. To address this issue, the Clonal Selection Algorithm (CSA) is proposed as an effective approach to enhance MPPT algorithm performance. The CSA dynamically adjusts the voltage perturbation size based on instant ambient irradiance and temperature, leading to improved global maximum power point tracking and enhanced efficiency in PV systems. Experimental results demonstrate the superiority of the proposed CSA over conventional MPPT algorithms, especially in scenarios with varying solar irradiance. The CSA's adaptability allows PV systems to operate closer to their optimal efficiency, maximizing energy harvest from available solar resources. Overall, this research contributes valuable insights into sustainable and efficient energy solutions by leveraging the capabilities of the CSA. Successfully integrating the CSA in PV systems plays a critical role in establishing an eco-friendly and resilient renewable energy infrastructure, for a greener future.

169 Two-Area Load Frequency Control using Particle Swarm Optimization

Min Keng Tan, Wei Han Lim, Kit Guan Lim, Wei Yeang Kow, Min Sian Ng and Kenneth Tze Kin Teo

Load Frequency Control is indeed important in any country that operates an interconnected power grid for regulating system frequency by adjusting the generation to match the load demand. To maintain the power system stability and improve efficiency in scheduling, this paper proposes Two-area Load Frequency Control (LFC) Optimization with Particle Swarm Optimization. The design process begins with understanding the fundamental concepts, starting from Automotive Generation Control in a single-area power system design and progressing to LFC design in a two-area power system. The two-area power system consists of Tie-line Bias Control (TLBC) for maintaining zero tie-line power and Area Control Error (ACE) for stabilizing system frequency. To achieve fitness results in simulations, this paper presents three modeling designs: a conventional design, a controller design, and a controller design with PSO. The results show a 70.0% and 53.4% improvement in the system frequency time schedule with the PSO model compared to the controller model and conventional model, respectively. Additionally, the PSO model demonstrates a 76.7% and 78.7% reduction in generation power deviation time schedule compared to the controller and conventional designs, respectively.

170 Improve Perturb and Observe Algorithm with Fuzzy Logic

Min Keng Tan, Braindane Owin Moloney, Kit Guan Lim, Soo Siang Yang, Hui Hwang Goh and Kenneth Tze Kin Teo

Photovoltaic systems generate direct current (DC)power by absorbing sunlight through photovoltaic cells. However, under non-uniform irradiance, multiple peaks in the Maximum Power Point Tracking (MPPT) pose challenges for precisely tracking the global maximum power point. Traditional methods often focus on local maximum power points instead of the global ones. This research aims to enhance the Perturb and Observe (P&O) approach and model the PV module to accurately track the Maximum Power Point (MPP). The study investigates the performance of PV arrays using models with non-uniform characteristics. While traditional MPPT techniques like perturb and observe (P&O) can track the MPP, they struggle with non-uniform irradiance, leading to output power fluctuations and losses. Simulation results demonstrate that the P&O-based MPPT algorithm, tailored for maximum power production, adjusts the operational point effectively. Comparing the conventional MPPT output voltage 17.8V under non-uniform irradiance of conventional P&O MPPT output voltage and a non-conventional Fuzzy Logic 33.8V under non-uniform irradiance indicates that the Fuzzy MPPT achieves52.66% of the output voltage obtained by the non-conventional MPPT comparing to conventional MPPT. These algorithms offer improved precision and flexibility, although their implementation may require higher processing power and computational capabilities. Therefore, the next focus will be on developing a fuzzy logic based MPPT and enhancing the photovoltaic system.

172 Multi-Step API Prediction in Malaysia: Evaluating Recursive NARX Neural Network and Recursive SVM Models

Rosminah Mustakim, Mazlina Mamat, Hoe Tung Yew and Farrah Wong

The increasing problem of air pollution has led to the advancement and improvement of air quality prediction studies. Predicting air quality in advance is crucial for mitigating the detrimental effects of air pollution on public health and economic activities. This study focuses on the development and evaluation of the Nonlinear Autoregressive Exogenous Neural Network (NARX) and Support Vector Machine (SVM) models for multi-step prediction of Malaysia's Air Pollutant Index (API). The models were constructed using a dataset from air quality monitoring stations in Malaysia's three prominent industrial areas: Pasir Gudang, Larkin, and TTDI Jaya. The model development process began by constructing a single-step API predictor, then developing and analyzing a multi-step API predictor using the recursive approach. The prediction performance was assessed using the Root Mean Square Error (RMSE) and Coefficient of Determination values (R2). The results indicate that the recursive NARX demonstrates promising performance compared to the recursive SVM in multi-step API prediction. However, additional analysis shows that the outliers strongly affected multi-step NARX's prediction, suggesting that the recursive NARX model cannot predict sudden fluctuations not seen in training.

173 IEEE 802.15.4 Signal Strength Evaluation in an Indoor Environment for Positioning Applications

Mohd Syafiq Daniel Wahab and Aroland Kiring

This paper presents an evaluation of IEEE 802.15.4 signal strength in indoor environments for positioning applications. The study involves experimental signal strength measurements, comparing different numbers and placements of access points (APs). The results reveal that signal strength variation is influenced by the quantity and strategic positioning of APs, the presence of obstacles, and the effects of multipath propagation. The theoretical path loss model is computed and compared with the empirical path loss model of the indoor setting. The study demonstrates the reliability of the calculated theoretical model in estimating IEEE 802.15.4 Signal Strength in indoor environments with an error rate of less than 5.5%. As a future research direction, the application of machine learning techniques is proposed to derive a path loss model that aligns better with real path loss data at specific points in the indoor environment. Such an approach promises improved adjustments to measured signal strength values, particularly in indoor settings.

174 A Mobile-Based Application for Detecting Sleep Deprivation using Deep Learning for University Student

Florence Sia and Lim Jo Ern

Sleep deprivation has been a norm for university students due to their unhealthy sleeping habits. It has significantly impact towards their study quality and performance. They will have trouble focusing, learning, and responding during class. Besides, it has adverse effect on their health which can lead to many diseases such as heart disease, diabetes, and stroke. There is a need to curb the ongoing unawareness of these effects. Students might not know they have sleep deprivation because it is often misjudged as lack of interest, loss of motivation, and laziness. There is no application and deep learning model has been developed yet to detect whether or not a person suffers from sleep deprived via face features. This paper proposes a mobile-based application to automate the sleep deprivation detection through the face features specifically eyes and mouth. A pre-trained deep learning model, MobileNet is proposed to identify and classify the sleep deprived and non-sleep deprived face images by using a public dataset of face images. The experiment results showed that the proposed MobileNet achieves high classification accuracy of 90%. A usability testing also has been conducted on the mobile application and the obtained results showed that the application can detect sleep deprivation well.

176 Design and Development of a Pipe Climbing Mechanism

Kean Teong Yeoh, Wai Heng Choong, Renee Ka Yin Chin and Bih Lii Chua

Tasks performed along outer side of pipeline such as paint-marking and inspection require climbing and carrying loads at height, which is hazardous to human. There are several pipe climbing mechanisms being designed recently. However, their selection of clamp method and actuators results in either too bulky, or low in payload capability. This paper aims to propose a design of pipe climbing mechanism (PCM) with higher payload per weight of PCM that can be remotely controlled. A wheel type PCM was developed with the ability to cover and move along a 110 - 150 mm pipe diameter while carrying a payload of 3 kg. The forward and backward motion of the PCM is remotely controlled via wifi connection. Several pipe orientations were tested by the PCM, including vertical, horizontal and slanted pipes to evaluate its climbing ability in terms of speed. The proposed PCM is capable to climb without payload and 3 kg payload at speed of 0.369 m/s and 0.244 m/s, respectively. The increase of payload on the PCM causes the moving time along a horizontal pipe to slightly increase. The orientation of pipe affects the moving time of PCM due to the act of gravity. In the end, the objective of this paper was achieved with a huge potential to explore for a more intelligent and functional design in the future.

177 Advancing Weed Detection in Agricultural Landscapes using Computer Vision

Bei Ren Tan, Ervin Moung, Muhd. Nur Afnan Uda, Kenneth Tze Kin Teo and Lorita Angeline

This paper explores the need for weed detection in agricultural landscapes, where weed infestations pose significant crop productivity challenges. To address this matter, computer vision techniques are utilised to create a weed detection algorithm that accurately detects weed patches inside agricultural field images. To ensure reliable model evaluation, the dataset is split into training and testing subsets before being fed into the YOLOv3 model. The YOLOv3 model performs well in terms of precision, with an average precision of 66.4% for crop regions and a notable precision of 92.5% for detecting weeds. These results highlight the potential of artificial intelligence-driven weed detection techniques to optimize crop management practices and foster sustainable agriculture in the modern era. This research advances precision agriculture by effectively addressing weed infestations, paving the way for more efficient and targeted weed control strategies, which ultimately lead to increased crop yield and improved agricultural sustainability.

178 Autonomous Path Optimization in Unfamiliar Map Through Deep Reinforcement Learning

Longxin Wei, Kit Guan Lim, Min Keng Tan, Chung Fan Liau, Tianlei Wang and Kenneth Tze Kin Teo

The application of mobile robot's path planning and navigation in known map scenarios has been well established. However, with the absence of a known map, the challenge lies in how a robot can effectively navigate through an unfamiliar environment and generate a sensible path towards its destination. This paper delves into the path planning quandary that mobile robot encountered in unknown environments. It employs a deep reinforcement learning (DRL) algorithm within a simulated environment, where the robot explores its objective. Additionally, an enhanced reward selection strategy is introduced through a performance-based comparison. This strategy tackles issues such as robot freezing and high collision rates during the exploration of uncharted territory. The outcome of this study is an enhancement in search performance and learning efficiency within path planning. The integration of this algorithm into the Robot Operating System (ROS) robot simulation platform, coupled with testing within the Gazebo simulation environment, demonstrates that the proposed strategy effectively diminishes obstacle collisions and boosts the success rate of reaching the intended destination.

179 Simulation and Batch Modelling of Microbial Biosurfactant Production

Helen Sin Ee Chuo, Andy Raymond Ramlan, Kit Guan Lim, Min Keng Tan, Hou Pin Yoong and Kenneth Tze Kin Teo

This project concentrates on simulating the batch microbial biosurfactant production in crude oil and its interfacial tension response. Bacterial metabolism has been widely studied for its significant role in bioremediation of oil spill, which is proven capable of reducing the interfacial tension between oil and water. Therefore, this simulation is integrated to observe the metabolic behaviour of the bacteria of interest upon its uptake of carbon source from crude oil, biosurfactant production and the system's interfacial tension which are some of the outputs mainly being discussed within the culture system. The metabolic process in the crude oil batch is first modelled, then simulated in MATLAB software, and the results are verified through literature and process theories, while the model was validated using the experimental data. The simulation will use a step size of 1/60 h, equivalent to 60 seconds, set to a total of 11520 iterations for a running time of 8 days. Different crude oil substrate concentrations are set to 1.5 g/L, 2.0 g/L, 2.5 g/L, 3.0 g/L and 3.5 g/L for parameter testing and the initial concentrations of biosurfactant and cell concentration are 0.02 g/L and 0.02 g/L respectively, while the initial interfacial tension is set at 70.8933 mN/m. The simulation outcome in this study signifies that the final concentrations of biosurfactant and bacteria cell increases with the increase in substrate concentration as crude oil degrades completely quicker with substrate concentration increase among culture batches obtained from the parameter testing. Additionally, the simulated interfacial tension profile plotted against biosurfactant from experimental research, showed similar profiles across batch cultures with an increasing substrate concentration where IFT is reduced from 70 ± 0.5 mN/m to 38 ±mN/m, but exhibited decreasing value of biosurfactant concentration defined at 0.5 micelle concentration (based on experimental value).

180 Evolutionary based Control and Optimization of Exothermic Batch Process

Huiyi Xu, Helen Sin Ee Chuo, Min Keng Tan, Chi Huey Ng, Min Yang and Kenneth Tze Kin Teo

Control and optimization of exothermic batch reactions are crucial tasks in the field of chemical engineering, with extensive applications in various industries such as healthcare, monitoring, and production. This review comprehensively analyzes the state-of-the-art evolutionary algorithms used for controlling and optimizing exothermic batch reactions. The paper explores and compares the performance of popular algorithms such as GA, PSO, and other hybrid evolutionary algorithms. The review focuses on the strengths and limitations of each algorithm, analyzing their capabilities in handling different exothermic batch reaction processes, including their applicability, robustness, and complexity. Additionally, the paper investigates the commonly used optimisation techniques based on evolutionary algorithms for controlling exothermic batch reactions in practical case studies. This review also reveals the latest advancements and emerging trends in this field, such as multi-objective optimization, multi-mode optimization, and the integration of deep learning methods.

181 Minimizing Energy Expenditures in Multi-Hop Transmissions with Genetic Algorithm

Kit Guan Lim, Qi Yang Chin, Min Keng Tan, Ali Farzamnia, Longxin Wei and Kenneth Tze Kin Teo

Wireless Sensor Networks (WSN) are placed in a specific field to gather, analyse, and collect data before sending it to the base station via various communication techniques and application layer protocols. However, a bottleneck in internet-of-things-based wireless sensor networks deployment is their limited bandwidth, battery power, and computing power capability. The major reason for low energy consumption and efficiency requirement is that WSNs are deployed in remote inaccessible locations and left alone and hence are difficult to recharge. The second reason is wireless sensors or Internet of Things (IoT) sensors are inherently power limited, as designed by manufacturers. This reduces the network lifetime and makes it a critical issue along with energy management. There are lots of algorithms that have been researched like Low Power Adaptive Clustering Hierarchy (LEACH), and LEACH variants such as Low Power Adaptive Clustering Hierarchy- Centralized (LEACH-C), Hybrid Energy Efficient Distributed (HEED), Power Efficient Gathering in Sensor Information Systems (PEGASIS), etc. In this study, existing literature are reviewed, and several routing algorithms are analysed to see how Cluster Head (CH) selection varies between them. An overview of methods influenced by genetics and nature-inspired algorithms and game theory routing protocol implementations are also included. The results are studied and compared on the state of the art for routing algorithms and an algorithm that presents an improvement over the previous reviewed works is proposed. The results show that genetic algorithm LEACH (GA-LEACH) outperformed LEACH and modified LEACH (MODLEACH) in terms of performance. Comparing with LEACH and MODLEACH, GALEACH greatly enhanced the network lifetime and improved energy consumption by 34.75% and 14.61% respectively.

182 IoT-based Multi-Level Sensors Electromyography (EMG) Acquisition System

Mohammad Shafiq Heiqal Bacho, Ismail Saad, Fatimah Ahmedy, Mohammad Saffree Jeffree, Nurmin Bolong, Kit Guan Lim and Kenneth Tze Kin Teo

In order to catch up with the increasing demand for advanced electromyography (EMG) acquisition systems in clinical rehabilitation, this research focuses on developing an innovative Multi-Level Sensors Based EMG Acquisition System. Unlike conventional single-channel EMG systems, this proposed system employs multiple sensors to capture muscle activity data from various muscle groups simultaneously. To address the need for remote and real-time data access, an Internet of Things (IoT) integration is introduced, enabling secure cloud-based storage and remote accessibility. The developed EMG acquisition system is designed to record patient-specific muscle activity data and corresponding average activity values, which are then uploaded to a cloud-based server. Healthcare professionals can remotely access the server through the user-friendly web link to retrieve patient data conveniently. The IoT-enabled approach enhances the system's scalability, cost-effectiveness, and potential for revolutionizing clinical rehabilitation practices. To validate the functionality of the prototype, extensive testing has been conducted, demonstrating its accuracy, reliability, and usability. This IoT-based Multi- Level Sensors EMG Acquisition System offers promising opportunities for rehabilitation programs, personalized treatment plans, and improved patient outcomes. As a result, this research presents a significant step forward in the field of clinical rehabilitation, offering innovative solutions for better patient care and rehabilitation monitoring.

184 **AGV Path Planning based on Improved Q-learning Optimization**

Hao Guo, Min Keng Tan, Kit Guan Lim, Helen Sin Ee Chuo, Baojian Yang and Kenneth Tze Kin Teo

With the development of modern industry 4.0, intelligent path planning is an essential research direction of schedule systems for an automatic guided vehicle (AGV), which has been widely used in logistics distribution centers of enterprises. This work implements the improved Q-learning algorithm in reinforcement learning to solve the typical obstacle avoidance problems in path planning. Specifically, the original Q-learning algorithm has shortcomings including low operational efficiency and slow learning speed. The improved Q-learning algorithm is successively proposed by adding a learning process based on the original Q-learning algorithm, which enables AGV to find obstacles and target locations within the shortest time, thus improving the efficiency of path planning. Finally, the simulation experiments are carried out in the grid environment with MATLAB. In comparison to the original algorithm, the improved Q-learning algorithm is found to possess faster convergence and higher learning efficiency improved by 20%.

185 **Evaluating Energy Efficiency and Sustainability in the Universiti Malaysia Sabah's (UMS) library through 6D Building Information Modelling (BIM)**

Nurmin Bolong and Hazler Alebaba

This research focuses on utilizing Building Information Modelling (BIM) technology, specifically its 6D dimension for Sustainability and Energy, to create a model of a library building on a university campus. By simulating the energy performance of the building, the study aims to identify areas for improved energy efficiency and provide recommendations for achieving this. The work used software tools like Autodesk Revit and Green Building Studio (GBS) to analyze the data. The study's results demonstrate significant energy savings and sustainability benefits in the built environment. A notable finding was the 80% reduction in lighting power density (LPD) achieved using sensors, which proved highly effective. Integrating BIM technology in building design and management can contribute to a greener and more efficient future. The 6D dimension of BIM can assist in making environmentally conscious decisions and optimizing performance, thus positively impacting the environment and future generations.

186 **Development of a Flexible Rogowski Coil Sensor for Partial Discharge Detection in Power Cables**

Kui Fern Chin, Chang Yii Chai, Ismail Saad, Asfarina Abu Bakar, Megat Muhammad Ikhsan Megat Hasnan and Lily Yong

Partial discharge (PD) is a prevalent problem in power cables that must be detected early to avert power outages and ensure system reliability. Despite the fact that numerous Rogowski coil (RC) designs, none of them can accommodate all cable sizes. The purpose of this research is to investigate the sensitivity of flexible RC sensors and develop a prototype that uses Thermoplastic Polyurethane (TPU) for enhanced flexibility and accuracy. This study emphasizes the significance of flexible RC sensors in early PD detection for enhanced flexibility and potential benefits for power system monitoring and maintenance. The RC construction is designed in AutoCAD and 3D printed in TPU. The RC is wound with 20 turns and employs a return loop method to reduce interference from external electromagnetic fields. According to experimental validation, the sensor sensitivity is directly proportional to the greatest amplitude of the recorded PD signal, demonstrating the potential to improve power system dependability and safety through early PD detection. These findings highlight the need to consider the PD signal's maximum amplitude for sensor sensitivity, ultimately adding to the power system's reliability and safety. The proposed design, characterized by its novelty with TPU materials, yields promising results in terms of flexibility, establishing flexible RC sensors as a feasible asset in power cable PD detection and boosting monitoring and maintenance practices.

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Characterisation of Data Augmentation Techniques using Visualisation

Kin Wai Lee and Renee Ka Yin Chin

Data Augmentation (DA) alleviates the dataspace limitations by generating new instances for training machine learning (ML) models. However, in practice, the effectiveness of the DA techniques adopted in varying downstream tasks lacks analytical explainability, mainly due to its domain-specificity nature. This paper describes a new ideation of characterising DA techniques from a visualisation perspective by explaining feature-space characteristics of augmented and original data in the high-dimensional space. This is accomplished by assessing the feasibility of using principal component analysis (PCA) for capturing the distinctiveness inherited by DA techniques. In a problem setting of COVID-19 CT detection, the proximity analysis suggests that computing PCA using low-dimensional features can contribute significant analytical values for the characterisation of DA techniques. The comparison of the clustering performances using data instances from the image and feature domains further highlights the significance of abstract features for more effective visual analysis and interpretation. Furthermore, the non-trivial connection between feature inputs and image outputs demonstrated in the connectivity analysis also indicates the significance of visualisation in analysing ML decisions, particularly with high level visual explanations.