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THEME

Sustainable Innovative Technologies for Development

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BOOK OF ABSTRACTS

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Welcome to the Engineering Conference, an important event organized by the School of Engineering Sciences, University of Ghana as part of its 20th-anniversary celebration program. This marks the first edition of the Engineering Conference, which will be organized on an annual basis. We have gathered at this maiden Engineering Conference to delve into the theme "**Sustainable Innovative Technologies for Development**".

In a world that is constantly evolving, the pursuit of sustainability and innovation is essential for progress. We have gathered here to discuss how technology can be a powerful force in shaping a sustainable future. Our shared commitment to finding innovative solutions that balance development and environmental responsibility is what unites us in this endeavour.

Throughout this conference, we will have the privilege of hearing from experts and students who have dedicated their efforts to advancing sustainable technologies through cutting-edge research. Their insights will inspire us to envision a future where development is not only achievable but also eco-friendly and socially responsible.

As we delve into various sessions and engage in discussions, let us remember that our collective actions have a lasting impact on the world. Our role as individuals and as a community is vital in driving positive change. The knowledge and collaborations that arise from this conference will undoubtedly contribute to a more sustainable and prosperous future.

I encourage you all to share your experiences, ask questions, and forge connections during this event. Let's seize this opportunity to learn, network, and inspire each other in our shared quest for sustainable, innovative technologies for development.

The success of this conference owes a debt of gratitude to numerous individuals, and we wish to extend our heartfelt appreciation for their invaluable contributions. Firstly, we extend our profound gratitude to all the authors for their outstanding submissions to the inaugural edition of the Engineering Conference. We also express our sincere appreciation to the dedicated members of the Engineering Conference planning committee, which included representatives from the School of Engineering Sciences Research Committee, Planning Committee, Awards Committee, and the Editorial Committee."

Thank you for being part of this important journey, and I wish us all a productive and enlightening conference.

KEYNOTE SPEAKER

PROF. ROBIN CLARK

DEAN OF WMG
UNIVERSITY OF WARWICK

- Dean of WMG at the University of Warwick from 1st October 2020
- Leading researcher in Engineering Education
- Chartered Engineer, Chartered Manager, National Teaching Fellow
- 17 years in academia (Aston University and University of Warwick)
- 14 years in industry – nuclear and rail sectors, UK and USA
- BSc(Eng) and PhD from UCL, MBA from WCSU

Having gained my Bachelors and PhD at UCL, both in Mechanical Engineering, I then spent 14 years in industry. Having completed a PhD in Non-Destructive Testing (NDT) sponsored by the nuclear industry, my first role in industry was at Rolls Royce and Associates, the part of Rolls Royce responsible for the nuclear plant on submarines. This was followed by a period at British Rail in the UK focusing on the NDT of traction and rolling stock. In 1995 I moved to the USA, to a company called Sperry Rail, and spent 8 years working on the NDT of railroad track, leaving in 2003 as Vice President of Engineering and R+D. Whilst in the USA I gained my MBA at the Ancell School of Business at Western Connecticut State University.

On my return to the UK in 2003 I changed direction and entered academia at Aston University. Education soon became my major interest. I gained my PGCHE and then worked through several positions becoming a Professor of Engineering Education and Associate Dean for Learning and Teaching for the School of Engineering and Applied Science. On the way I became a National Teaching Fellow and founded the UK and Ireland Engineering Education Research Network (which I still lead today).

In 2017 I moved to WMG (formerly Warwick Manufacturing Group) at the University of Warwick, became Director of Education in August 2019 and Dean in October 2020. WMG is the largest Department of the University of Warwick (77th in the THE World University Rankings) with a turnover of just over £100m per year, with 850 staff, 3000+ students and 250 PhD students.

Over my career I have published 20 journal papers and 150 conference papers, have edited one 2 volume book (Handbook of Research on Engineering Education in a Global Context), have 4 US patents, supervised 6 PhD's to completion (have 3 in progress), have supervised 75 MSc and Bachelors projects to completion, have performed various external examiner duties (courses and PhD's) and won £550k of research funding. I have served two 3 year terms on the SEFI Board of Directors (2014-2020) and was the Scientific Chair for the 2014 SEFI Conference in Birmingham, UK.

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Basic Research

Posters

Local Fibrous Materials (*Sugar Cane & Plantain Stem)* for Crude Oil Spillage Remediation in Ghana

S. Gbogbo*, Y.A. Kwakye, D. Narh, B. Agyei-Tuffour, E. Nyankson

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Background/Objective

Oil spills pose danger to both marine and terrestrial life. It has ripple effects on tourism, health and the economy of nations as a whole. This calls for swift and improved responses that are efficient, environmentally friendly and less costly. In this study, plantain pseudo-stem (PF) and sugar cane (SF) fiber sorbent materials were modified with TiO_2, graphene oxide (GO), and stearic acid (SA) to enable them separate oil/water mixture and for that matter able to remediate crude oil spill.

Methodology

The schematic diagram below shows the proposed methodology for this research**.**

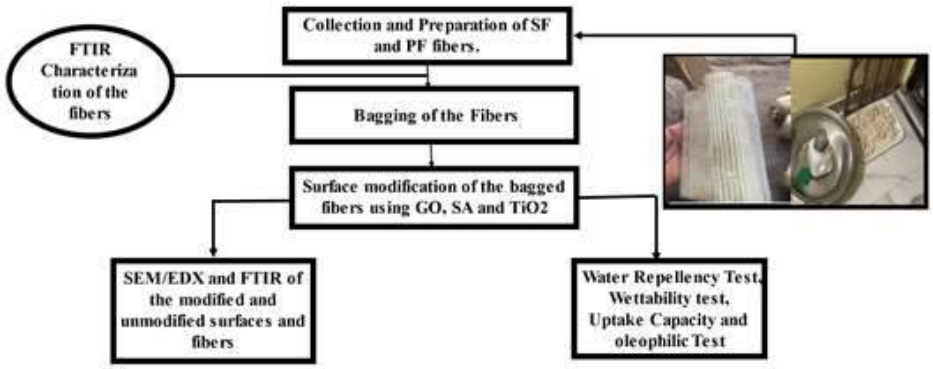

Figure 1. Modified sugar cane and plantain pseudo-stem fiber, its characterizations and applications

Results

Modified SF & PF sorbent materials has been successfully prepared by functionalizing bagged SF & PF natural fibers with TiO_2, graphene oxide (GO), and stearic acid (SA). The modified SF produced a contact angle of 144.04° from an intrinsic value of 62.86°, while the modified PF sorbent material produced 126.31° from an intrinsic value of 46.45°. The modified SF sorbent material can absorb 10.29g/g of crude oil while the PF sorbent material absorbs 5.77g/g. Both types of sorbent materials have been successfully used for the separation of the oil/water mixture.

Conclusions

The modified TiO_2-GO-SA/(SF&PF) sorbent materials being hydrophobic is a promising candidate for oil spill remediation application.

***Keywords*:** sorbent material, plantain fiber, sugar cane fiber, oil spill remediation, hydrophobicity.

Chicken Feather Protein Dispersant for Effective Crude Oil Dispersion in the Marine Environment

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Background

Various studies report that aside the adverse impact of the crude oil on the marine environment, there is the likelihood that chemical dispersants used on the surface of water as oil treating agents in itself possess a degree of toxicity which have additional effects on the environment. To eliminate the subject of toxicity, there exist several materials in nature which have the ability to form good emulsions and such products include protein molecules.

Methodology

In this study, chicken feathers which are known to contain >90% protein was used to formulate a novel dispersant to disperse crude oil in sea water (35 ppt). Protein from chicken feathers was extracted and synthesized into chicken feather protein (CFP) dispersant using deionized water as solvent. The CFP extract was characterized by FT-IR and NMR spectroscopy analyses. Dispersant formulated from CFP was examined by emulsion stability studies, droplet size analysis, surface and interfacial activity tests, dispersion effectiveness using the baffled flask test and acute toxicity studies.

Results

Emulsions formed from CFP synthesized dispersants were stable over a considerable long period of time whereas the average droplet size of emulsion formed was 11.9 μm, which is very small in diameter, making droplet coalescence almost impossible. The CFP dispersants exhibited moderate surface and interfacial activity at normal sea water salinity. Using the US EPA's baffled flask test, at 800 and 1000 mg/ml CFP surfactant-to-oil ratios respectively, dispersion effectiveness of 56.92 and 68.64 Vol% were obtained respectively, which shows CFP has a great potential at crude oil dispersion. Moreover, acute toxicity test performed on Nile tilapia showed that CFP was practically non-toxic with an LC50 value, more than 100 mg/L after 96-hour exposure.

Conclusion and Impact

The results obtained showed that chicken feathers contain proteins and the dispersant formulated from it is environmentally friendly and has a good potential in crude oil spill remediation.

***Keywords*:** Protein, Chicken feathers, Dispersant, Oil spill, Toxicity

Designing an Automated Pain Relief System (APRS)

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Background

The National Library of Medicine explored whether pain should be considered a disease or a symptom in an article written in 2017. As one of the most common sensations known to man, it is expected that there will be more progression in the development of pain relief methods. However, that seems not to be the case. This report focuses on the design of an Automated Pain Relief System (APRS), a Transcutaneous Electric Nerve Stimulation (TENS) device created by a group of biomedical engineering students. The goal of this project is to introduce an innovative system for pain alleviation in hospitals. The scientific understanding of pain as a neuro-physiological phenomenon and the need for effective pain management provide the motivation for this project.

Methodology

The design of the APRS system was developed through extensive reading and research on transcutaneous systems and existing TENS technologies. The design process was divided into the circuitry design and conceptual design. Computational tools such as the Proteus for the circuitry design and LTSpice for electrical simulations to determine the amount of current that is running or present in every point of the circuit. It is a necessary requirement to determine the full functionality of the circuitry design, seeing as the APRS is a combination of multiple control units.The conceptual design, governed by several parameters including user-friendliness and aesthetics, was done using CAD specifically SolidWorks.

Results

Research already exists to prove that TENS technology is more efficient at relieving pain with the least possible side effects compared to the basic pain medication. Simulation results show that the APRS will run smoothly.

Conclusion and Impact

The APRS is expected to significantly improve pain relief and management in healthcare. Its non-invasive approach, enabled by modern technologies and precise parameter selection, makes it a promising candidate for future advancements in pain management. Features like its compact design, and wireless connectivity add to its potential. The report highlights areas for further optimization and future research.

***Keywords*:** Automated Pain Relief System (APRS), Transcutaneous Electric Nerve Stimulation (TENS), Pain management, Non-invasive

Recycling and Processing of Egg Shells and Bovine Bone into Functional Biomaterials: from Processing to Structure, Cell/Surface Interactions and Bioactivity

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Abstract

In this study, eggshell and bovine bone were recycled and processed, using wet precipitation and calcination methods, into nano-scale hydroxyapatite (HAp) structures for functional biomaterials. The resulting powders were then compacted into pellets and then heated at three temperatures (700, 900, 1100^{o}C) to produce HA nano-pellets with well controlled microstructures and pore sizes. Nanostructures of HA were then coated onto HA and Ti-6Al-4V substrates to provide favorable surface textures for initial cell spreading and integration. The structure, cell/surface interactions and bioactivity of nanostructured coatings are then elucidated before discussing the implications of the current work for the recycling of eggshells and bovine bone into functional biomaterials.

Using Machine Learning to Make Social Media Safe for Kids

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Abstract

Since the dawn of the internet, there has been a steady growth in the number of users with as much as 66% of the world's population being users. Surveys have shown that children are spending more and more time on the internet and social media, however, there are many things that could be harmful to them on the internet from hate speech to child predators. Many sites that contain things that may be potentially harmful to children use Age gates. These systems are quite redundant and unreliable. A better, more robust solution is using biometrics or a valid ID to verify age.

A computer vision system using biometrics and/or an ID card was developed for more accurate age verification. This system employed machine learning techniques such as face verification using an inception_v2 architect and Facenet weights, optical character reading using a python library called easyOCR, face extraction using a python implementation of a multi-task cascaded Convolutional Neural Network, and age classification using multiple VGG16 architectures and transfer learning. A few preprocessing techniques were employed such as dilation morphology and image binarization using OpenCV to enhance optical characters and reduce noise.

A mobile application that implements an enhanced age verification system was designed to protect and enable a safe space for children by ensuring that only children of an appropriate age limit were allowed access to the social platform. The social application also annihilates the effect of teens feeling "left out" if they cannot emulate the lifestyles and appearances of "influencers" by eliminating the pressures the comes with traditional social app features such as likes, comments and followers that have been implemented on some other platforms. By inducting a set of carefully analyzed requirements for a social and messaging app for kids, the system provides a platform where kids can text, use emojis and stickers, share pictures and educational media including videos and documents and use audio and video calling features to connect with friends.

The performance of the proposed solutions shows that age verification using biometrics is a valid method that can be employed to improve the safety of children online.

Keywords - internet, verification, social media, machine learning.

Antimicrobial Aluminum Surfaces for Curbing Healthcare Associated Infections

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Abstract

Healthcare associated infections, is a serious public health problem. Besides antibacterial, antifungal and antiviral therapies, one potential strategy for breaking the chain of infection transmission is via installation of antibacterial surfaces. Aluminum is an attractive material for fabricating frequently touched surfaces such as doorknobs, push plate, bedrails etc. Recently, our research group and others have demonstrated that utilizing appropriate surface treatment technology, aluminum could be rendered antibacterial.

In the present work, a one-step hard aluminum anodization process has been employed to fabricate novel antibacterial aluminum surface by controlling concentration of different electrolytes, current density and anodization time. Optimal surface morphology with diameters 151 ± 37 nm was found to provide excellent antibacterial properties, efficiently killing 100% Escherichia-coli (*E.coli*) bacteria. Additionally, superhydrophobic aluminum surface, achieved by combined effects of nano-rough porous anodized aluminum-Ag-PMHS nanocomposites, and low surface energy passivation, resulted in bacterial adhesion reduction of 99.0 %, 99.5 %, and 99.3 % for *Pseudomonas aeruginosa* (P.A.), *E.coli* and *Staphylococcus aureus* (S.A.), respectively. Finally, utilizing a two-step electrochemical deposition process, silver phosphate (Ag_3PO_4) was incorporated in nanopores of anodized aluminum, which led to 100% *E. coli* bacteria inactivation.

Overall, novel aluminum surface technology strategies such as anodization, low surface energy passivation and electrochemical surface modification on AA6061-T6 aluminum alloy, proves to be efficient in antibacterial activities as well as in robustness and durability. These novel surfaces showed the ability of reducing microbial burden of clinically relevant and Healthcare associated infections implicated pathogens, namely, S.A., P.A. and *E. coli*.

Keywords: healthcare associated infection, antibacterial surfaces, aluminum.

Designing a Home Management System Using Sensors, Fire Alarms and Monitoring Devices

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Background

In an era of increasing technological advancements, the integration of smart technologies into our daily lives has become a reality. This research explores the design and implementation of a comprehensive Home Management System (HMS) that leverages sensor technology, fire alarms, and monitoring devices to enhance safety, convenience, and energy efficiency within residential environments. The central focus of this research is the creation of a versatile Home Management System (HMS) that seamlessly integrates with everyday life.

Methodology

Our primary focus was on creating a user-friendly mobile application to empower homeowners in managing their home environment remotely. We adopted an architecture, allowing for scalability and customization, ensuring that the system can adapt to diverse user needs. Our research encompassed various technical elements, including sensor selection, communication protocols, software development, mobile application creation, and system wiring. We followed an iterative approach, involving rigorous testing, and continuous refinement to guarantee the system's reliability and responsiveness.

Results

The project aimed to design and implement a home management system incorporating sensors, fire alarms, and monitoring devices to enhance home security and automation. During the project, several significant findings emerged. Firstly, the development of user-friendly interfaces for various devices was a notable success, enabling homeowners to easily control and monitor their homes remotely, regardless of their technical expertise. This made the system accessible to a wide range of individuals. Another key finding was the system's scalability and performance. It effectively accommodated additional devices and users without compromising response times or resource utilization, demonstrating its suitability for various residential settings.

Conclusion and Impact

In conclusion, the integration of motion sensors, fire alarms, and monitoring devices into a centralized system has proven to be an effective approach to enhancing home security, energy efficiency, and comfort of home users. The impact of this research is it contributes to the growing field of smart home management and security, offering valuable insights for future research and development. The user-friendly interfaces and the emphasis on accessibility bridge the gap between technology and homeowners, making the concept of a "smart home" more approachable.

Keywords: Home Management System (HMS), Sensor technology, Voice recognition, Smart home systems, Internet of Things (IoT)

Design of a Remote Vital Signs Monitor for Clinical Application

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Background

Vital signs are pivotal indicators of one's overall health, offering insights into the body's essential functions. These measurements encompass heart rate, body temperature, blood oxygen saturation (SPO2), and blood pressure, serving as vital clues to potential health issues and overall well-being. Our project focuses on the development of a revolutionary remote vital signs monitor, aptly named WABBvitals. This project is not only aimed at enhancing the precision of vital signs measurements simultaneously using a single device, but also introduces an innovative approach to blood pressure measurement, replacing the traditional cuff method with a parameter known as pulse transit time (PTT).

Methodology

WABBvitals integrates various biological sensors with in-built signal conditioning units and a sophisticated algorithm to deliver accurate measurements of body temperature, heart rate, pulse, and blood pressure. Temperature was measured with LM35 sensor, while pulse rate and heart rate were measured with MAX30102 sensor. Blood pressure was estimated using the pulse transit time (PTT), which is the time it takes for the pulse wave to travel from the heart to a peripheral part of the circulatory system. These sensors were connected to a microcontroller, and the data were processed and displayed on an OLED screen. Simultaneously, the data were transmitted to ThingSpeak via Wi-Fi for graphical visualization and remote access.

Results

The Vital Signs Monitor successfully measured and displayed temperature, pulse rate, heart rate, and blood pressure. The standard IR thermometer, Pulse Oximeter and the Digital Sphygmomanometer were used to measure the vital signs of 10 students and these WABBvitals was used to measure the vital signs of these same students to access the accuracy of our device. The comparison showed consistent positive outcomes between the measurements by the standard devices and WABBvitals. Remote access through ThingSpeak allowed healthcare providers to monitor patients in real-time, enabling early intervention when necessary.

Conclusion and Impact

WABBvitals holds the potential to reduce the frequency of health visits, particularly benefiting the elderly, and alleviate overcrowding in healthcare settings in Ghana and other low-income countries. With its focus on enhancing vital signs measurement and enabling remote monitoring, WABBvitals represents a remarkable stride towards accessible and efficient healthcare, redefining healthcare. Further research on the use of PTT, and integration of measured vital signs with electronic health records (EHR) systems could lead to more widespread adoption and further improvements in patient care and disease management.

Keywords: Pulse Transit Time, Vital Signs, Remote Monitoring, Algorithm, Sensors.

Off-Campus Accommodation System for the University of Ghana

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Abstract

In recent times, there has been a higher demand for accommodation for the students at the University of Ghana. This surge in demand has highlighted the crucial need for effective data management in the realm of student hostel accommodations, with particular emphasis on the indispensable role of a web-based Student Hostel Management System.

To design and implement such a system, a comprehensive study was conducted at the University of Ghana. The study employed a well-thought-out research design that incorporated various data collection methods, including observation, semi-structured interviews, questionnaires, and document analysis. This meticulous investigation revealed the limitations of the existing manual hostel management system, prompting the development of a web-based alternative.

The Web-based Student Hostel Management Application System is an online platform crafted using the PHP programming language and backed by a MySQL database. It serves both students and the administrative staff responsible for registration and hostel management processes. HTML forms the front-end of the system, providing a user-friendly graphical interface, while the MySQL database handles data storage at the back-end. This system not only facilitates the creation and management of student records but also ensures timely updates of student profiles.

Furthermore, this innovative system significantly enhances hostel services for students seeking accommodation by offering convenient online access and streamlining various hostel-related tasks. It automates the student accommodation application process, efficiently allocates rooms to students, provides real-time application status notifications, and maintains data integrity by employing password protection to restrict access to authorized individuals.

Our system has been hosted on the University of Ghana website and it has proven to be stable with the queries received.

Keywords: database, records, web-based, online.

Design of a Sanitizing System for Enhanced Hygiene and Safety

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Abstract

In the era of COVID-19, there was the need for enhanced sanitization measures to reduce the spread of the virus. Our goal was to create a functional and convenient solution that promotes cleanliness and hygiene in various environments by employing the formal engineering design process to design a sanitizing door using SolidWorks.

The design features a handle with perforated holes and an embedded compressor staging a sanitizer bottle within the door. The perforated holes in the handle allow the sanitizer to flow through, while the embedded compressor ensures a consistent simulated supply. By simply turning the door, the simulated sanitizer is dispensed through the simulated mechanism, providing a convenient and user-friendly experience. The design process in SolidWorks allowed us to create a detailed and realistic 3D model. While physical testing is necessary to validate the design's functionality, SolidWorks provided a platform to visualize and iterate on our concept quickly. This enabled us to make necessary adjustments and improvements to enhance the door's functionality and aesthetics.

To ensure the effectiveness of our design, extensive simulations were conducted. We simulated the amount of sanitizer dispensed and assessed its efficacy in eliminating harmful germs. While these simulations are yet to be validated through physical testing, the results indicate the design's potential to maintain cleanliness and hygiene standards effectively.

In conclusion, our SolidWorks-designed sanitizing door showcases a potential solution to promote cleanliness and hygiene in various environments. Further testing and validation are required to ensure its functionality and efficacy.

Identification of Potential Inhibitors Against Lactate Dehydrogenase of Cryptosporidium Parvum Through a Combined *In silico* Approach.

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Abstract

Cryptosporidium is a parasitic protozoan responsible for an acute gastrointestinal infection, known as Cryptosporidiosis. This disease can be particularly severe in individuals with weakened immune systems and children. The primary treatment for cryptosporidiosis is nitazoxanide, the only FDA-approved medication for this condition. However, recent reports suggest a reduced effectiveness and the emergence of resistance to nitazoxanide. Furthermore, nitazoxanide may be ineffective in individuals with compromised immune systems. Therefore, there is a need to explore novel pathways to identify new compounds with alternative mechanisms of action. A combined *in silico* approach consisting of homology modelling, pharmacophore-based screening, molecular docking, and binding interactions studies was employed in identifying potential bioactive compounds by targeting *Cryptosporidium parvum* Lactate dehydrogenase (CpLDH), an essential enzyme in the glycolytic pathway. Nitazoxanide, along with five potent CpLDH inhibitors, formed the training set to generate a robust 3D pharmacophore model via LigandScout with a score of 0.725. This validated model served as the basis for screening a collection of 4924 African natural products. 191 top-hit compounds were docked against a modelled structure of CpLDH. The docking protocol's effectiveness was assessed using the Area Under the Curve (AUC) of the Receiver Operating Characteristic (ROC) curve. Ligplot+ was utilized to gain insights into protein-ligand binding mechanisms and interactions. The results obtained from the docking studies were further corroborated through molecular dynamics simulations. The study identified 19 molecules with binding affinities ranging from -9.2 to -10.2 kcal/mol as potential bioactive compounds. Biological activity predictions with a probability of activity (Pa) greater than 0.3 revealed that 14 of the compounds possessed anti-inflammatory properties, 14 had antiprotozoal characteristics and 5 exhibited antiparasitic activity. Based on the results, these compounds are believed to have the potential to disrupt the conversion of pyruvate to lactate, a critical step in *Cryptosporidium parvum*'s glycolytic process, ultimately inhibiting its growth. The compounds were predicted to possess good pharmacological profiles, hence their putative anti-cryptosporidial action can be utilized upon experimental validation.

***Keywords*:** Cryptosporidiosis; Anti-cryptosporidial; Pharmacophore modelling; Molecular docking; Natural product.

Tutors' Use of Cognitive Activation to Support Effective Teaching of Mathematics in the Colleges of Education

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Background

Mathematics is the foundation to science, technology and engineering, however, mathematics and science scores by learners at all levels are always poor. Though mathematics teaching strategies in the colleges of education give priority to student-centered, problem-solving, and critical and reflective thinking techniques with emphasis on practical sessions, this does not reflect in the performance of learners who are mostly handled by graduates from the colleges. Meanwhile, constructivist theory is explicitly prescribed in mathematics syllabi as instructional strategy at the basic level. This study therefore, considered cognitive activation to confirm whether or not constructivism is used by the tutors to teach mathematics. Cognitive Activation (CA) is an effective instructional strategy which emphasizes constructivist theory that knowledge is better acquired when the learners construct their own understanding of mathematical concepts. The Programme for International Student Assessment identifies CA as a strategy that supports the development of mathematical literacy, exposing learners to mathematics activities (OECD, 2013) as they use their existing knowledge and experience (Klieme, Pauli &Reusser, 2009) to explore new concepts stimulated by questions (Lipowsky et al., 2009) to excite the learning process (Klieme et al, 2009).

Methodology

A cross-sectional quantitative data was collected from 621 third-year (2019/2020) teacher-trainees in three colleges in the Volta Region as convenience sample frame, using a questionnaire whose variables were measured along a 5-point likert-scale to determine tutors' use of cognitive activation in mathematics lessons. The instrument was internally consistent with Cronbach's Alpha coefficient of 0.932 and externally consistent with Cohen's Kappa's interrater technique value of 0.924 for the 14 items that explained CA. The face, construct and content validity tests were also conducted to ensure scale validity of the instrument. The data were analysed using the binomial test with 0.5 p value, the descriptive statistic and composite score analysis of the likert-scale responses.

Results

The mean likert-scale response of 3.811 was corroborated by the composite score of 3.810. in addition, with a mean standard error of 0.044 and mean standard deviation of 1.096 which were significant at 95% confidence interval, 69% of the respondents agreed that college tutors use CA strategy to deliver mathematics lessons. It is therefore accepted that college tutors use constructivism to teach mathematics.

Conclusion and Impact

The study revealed that tutors in the colleges of education use cognitive activation to effect constructivism in mathematics lessons. This will consequently have impact on the teacher-trainees to deliver effective mathematics lessons.

***Keywords*:** constructivism, cognitive activation, instructional strategies

Gate Automation Systems Using Access Control Mechanisms

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Background
In an era defined by rapid technological evolution and security advancements, innovation and integration of access control mechanisms into daily security systems have become expedient. Contemporary access control mechanisms seek to improve security as well as keep a record of access events. In this research, a Gate Automation System that implements License Plate Recognition (LPR), Radio Frequency Identification (RFID), and Mobile phone technology was designed and demonstrated.

Methodology
The system's design comprised a flexible architecture that allowed for easy scalability and customization. This research explored the technical aspects of the design, including component selection, communication protocols, software design and development, and system wiring. The development process followed an iterative approach, involving prototyping, simulations, testing, and refinement to ensure system reliability, responsiveness and robustness. For the LPR sub-system, we implemented a network camera that received images from the environment and sent signals of those images, processed through a Python code we designed to detect license plate numbers introduced within the scope of the camera's view in real-time. The mobile phone technology sub-system was also designed using a GSM controller connected to the motor of the gate to allow for calling and or text messages to operate the gate. The subsystems were integrated to form an automated gate system that was secure and kept track of access events.

Results
The system featured a user-friendly web application that served as the primary interface for security personnel as well as regular home owners to monitor and control access to the premises through the gate. License plate recognition technology was a cornerstone of the design, which was programmed to allow and deny access based on license plate recognition protocols set by a user or operator. The results of this research demonstrated the potential for enhanced safety, customer convenience, and tighter security in modern premises through the integration of several access control mechanisms for monitoring. The system demonstrated the ability to process images, successfully extracting license plate numbers from vehicle images captured by the network camera. These numbers were efficiently cross-referenced with the database. Furthermore, the system effectively maintained a comprehensive record of access events through the utilization of the established database.

Conclusion and Impact
The gate automation system integrated multiple access control mechanisms and offered secure and convenient entry options. Moreover, it provided robust monitoring capabilities through an intuitive web application interface, enhancing both security and user experience. These achievements align perfectly with the aims and objectives we initially set for the system's performance. The execution of this project is poised to significantly enhance premises security and facilitate comprehensive access event monitoring. Furthermore, it offers a cost-effective alternative to traditional gate automation systems by leveraging network cameras, which are notably more budget-friendly compared to specialized Automatic Number Plate Recognition (ANPR) cameras.

***Keywords*:** License Plate Recognition (LPR), Radio Frequency Identification (RFID), Automation, Sub-system, Protocols. Global System for Mobile Communication (GSM), Automatic Number Plate Recognition (ANPR)

Health Kiosk: An IoT-Based Community Health Center

Abstract

Timely access to quality healthcare is essential to the well-being and health of individuals in any community. However, access to healthcare has been a significant problem throughout the world. The WHO estimates that over 50% of the world's population does not have access to needed healthcare services. This reveals the massive gap between the availability and the demand for healthcare facilities. In Ghana and most developing countries, the lack of health facilities has resulted in hospital overcrowding and pressure on the available facilities. It is against this backdrop that this project seeks to design and develop an Internet of Medical Things (IoMT) Point of Care (POC) system (called the Health Kiosk) to bridge the gap between the availability and demand for healthcare at a relatively lower cost. The Health Kiosk comprises a hardware component that collects patient's vitals and transmits them to an online database. The vitals can be accessed from a web application that collects patient health records and enables doctors to provide diagnoses and prescriptions. This system also provides a means for doctors to track their patients' medical history while allowing patients to monitor their health on the go. Preliminary results show that the web application's user interface is intuitive, and its features provide adequate functionalities that enable both patients and doctors to interact effectively. Also, the system requires an integration of medical-grade sensors for higher accuracy and confidence in the vital signs being measured from patients to enable doctors to provide diagnoses with better certainty.

***Keywords*:** Health Care, Internet of Things, Health Kiosk, Point of Care, Health, Hospital, Medical Devices, Internet of Medical Things, Web Application, Health Monitoring.

Improvement of SeaLion Bio-Inspired Optimization Algorithm

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Background

Optimization of complex problems remains a continuous challenge across various fields, and bio-inspired algorithms have gained attention for their ability to provide efficient solutions. One such algorithm is the SeaLion Optimization Algorithm (SLOA). This algorithm draws inspiration from the cooperative hunting behavior of sea lions, where they move strategically in groups to locate and capture prey. Although the original SLOA has shown promising results, it struggles with fine-tuning parameters, adapting to dynamic landscapes, and achieving faster convergence rates. This paper presents an improved version of the SLOA designed to enhance the algorithm's ability to solve high-dimensional problems, enhance search efficiency, and improve convergence rates.

Methodology

In this paper, several key enhancements have been done on the original SLOA, to improve its overall performance. Firstly, a Sine-Based Chaotic Initialization is implemented to serve as a technique to inject controlled randomness into the initial population. The sine-based chaotic initialization ensures an efficient exploration of the solution space, enhancing the algorithm's ability to discover high-quality solutions. The second notable improvement involves the integration of an Epsilon-Greedy Selection approach during the exploitation stage. This selection strategy introduces a simple and effective way to explore new parameters of the SeaLion to improve its accuracy. An empirical evaluation of the proposed improved algorithm is conducted on a diverse set of benchmark problems, spanning continuous, combinatorial, and multi-objective optimization tasks in MATLAB. The results of the improved Sea lion were compared to the traditional SeaLion, the Ant Colony Optimization (ACO) algorithm and Particle Swarm Optimization (PSO) algorithm in MATLAB.

Results

The experimental results showcase the remarkable superiority of the proposed algorithm over the original SLOA and several state-of-the-art optimization algorithms with regard to convergence rates and solution quality. Moreover, the algorithm's behavior proved the impact of Sine-Based Chaotic Initialization and Epsilon-Greedy Selection on the algorithm's exploration and exploitation capabilities in dealing with both low-dimensional and high-dimensional problems.

Conclusion and Impact

In this paper the efficiency of the traditional SeaLion Optimization algorithm has been modified to find solutions quickly and accurately. The development of the improved algorithm provides a significant contribution to the body of knowledge in computational intelligence that will enhance decision-making in various fields. By leveraging on key parameter tuning, this improved algorithm offers a more effective approach to finding optimal solutions in a wide range of complex industrial problems.

***Keywords*:** SeaLion, Bio-inspired, Sine-Based Chaotic mapping, epsilon-greedy selection method, optimization.

Biochar as a Soil Amendment Tool: Effects on Soil Properties and Yield of Cabbage (*Brassica oleracea L.)*

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Abstract

This study conducted at the University School Farm, University of Ghana, Legon, aimed to assess the impact of two biochar applications on soil properties and cabbage crop yield. A randomized complete block design (RCBD) was employed in a 20 m by 5 m plot, divided into 3 blocks with 6 treatments replicated 3 times. The treatments included sugarcane biochar (SB), coconut biochar (CB), sugarcane biochar plus NPK (SB+NPK), coconut biochar plus NPK (CB+NPK), NPK, and a control (CT). The results indicated that biochar application, particularly the CB, led to a reduction in bulk density, enhancing soil porosity and allowing better root penetration for nutrient and water absorption. The application of biochar significantly adjusted the soil pH, bringing it closer to the neutral range necessary for optimal crop development. CB+NPK notably produced the most favorable results in terms of plant height, leaf dimensions, and yield components such as head diameter, total weight, head weight, leaf mass, and root mass. Overall, the findings highlight the positive influence of biochar on soil properties, nutrient availability, and water retention, ultimately improving cabbage crop productivity. While the study underscores the benefits of biochar application, it also suggests the need for further research to explore long-term effects, optimal application rates, and the specific impacts of biochar on various soil types and plant species.

***Keywords*:** Biochar; soil pH; bulk density; cabbage productivity; soil quality and health

Effects of Organic and Inorganic Fertilizers on Soil Quality and Cabbage (*Brassica oleracea L.*) Productivity

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Abstract

Fertilizers, both organic and inorganic, play a crucial role in enhancing soil fertility and influencing the growth and yield of agricultural crops. This study, conducted at the University of Ghana farm, aimed to assess the impacts of organic and inorganic fertilizers on soil fertility, soil characteristics, and the growth and yield of cabbage. The experiment utilized processed poultry droppings mixed with sawdust (PSW) and processed human fecal waste (HW) as organic fertilizers, in addition to the inorganic fertilizer NPK, with a control (CT) setup. A randomized complete block design (RCBD) was employed, with three replications for each of the four treatments across a 19 m by 5 m plot. Results revealed that PSW exhibited the most significant enhancement in soil properties, including the reduction in soil bulk density, improved porosity, and an increase in the pH level towards neutrality (7.35). The PSW resulted in the most remarkable growth and yield parameters of cabbage crop, demonstrating the tallest plant height (18 cm), the heaviest total weight (1687.4 g), the highest leaf count (28), and the broadest leaf dimensions (27 cm length and 28 cm breadth). Among the various organic and inorganic fertilizers studied, the PSW treatment emerged as the most effective in improving soil quality and productivity of yield of cabbage crop. The success of the experiment highlights the potential of organic fertilizers to significantly enhance soil quality and crop productivity strongly recommending the application of PSW for agricultural practices, considering its ability to enrich soil fertility, improve soil characteristics, and optimize cabbage crop yield.

Keywords: Soil fertility, organic and inorganic fertilizer, growth parameters, cabbage yield

Development of a Digital Hardware Interface System for Analog Energy Meters for Smart Metering and Billing.

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Background

Energy consumed by users (residential, commercial, and industry) is usually recorded by energy meters installed at the premises for billing. Non-smart and Smart are forms of energy meters with enhanced features to facilitate remote monitoring. With the non-smart meters, agents of the utilities visit the premises of the users to manually record the data or use a form of data logger. While many developed economies have transitioned from non-smart to smart energy meters for remote monitoring; Incidentally, most developing countries still have a considerable number of non-smart meters due to the high cost of replacement. For example, the Electricity Company of Ghana (ECG) still has 47% of its active residential users using non-smart meters. This project offers a solution that involves the integration of a digital hardware interface to the non-smart meter with a mobile application to facilitate remote monitoring of user consumption for billing.

Methodology

The developed digital hardware system has integrated sensors for monitoring the voltage and current, a microcontroller unit with operational logic, a communication module, and a user display system. The digital hardware, which interfaces the user's non-smart meter, acquires the current and voltage readings and the microcontroller computes the average power and energy consumed by the user. The consumption data is then transmitted using the GSM communication to the cloud server of the utility. With the mobile application, agents of the utility access the consumption data of a user at their convenience. While utility agents provide meter IDs of residential users, the system provides the physical location, energy, and power consumption records of the user instantaneously.

Results

In the experiment, a user with multiple appliances (smartphone, soldering iron, and electric kettle) was assumed and operated for 2 hours. The power ratings of the appliances were 20W, 60W, and 1875W, respectively. The digital hardware could adequately capture the power and energy consumed by the user for the period.

Conclusion and Impact

With the digital hardware interface system, it is possible to remotely monitor the energy consumption from non-smart energy meters on the premises of users without physical visits and with reduced errors from the manual readings. This solution further helps the utility to detect illegal meters that have been exported to other regions. Moreover, the solution will help the utilities by improving the efficiency of the user data and ensuring fair and prompt billing, especially for smart metering in rural areas.

***Keywords*:** Analog Energy Meters, Smart energy meters, Remote Data Access, Digital Hardware Interface.

Design of an Interpretable Deep Learning Model for Prostate Cancer Diagnosis

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Background

Prostate cancer (PC) is one of the most common and deadly cancers among men worldwide. Early and accurate diagnosis of PC is crucial for improving the survival of patients. However, current diagnostic methods, such as biopsy and prostate-specific antigen test, face a challenge of overdiagnosis and are prone to human error. Therefore, there is a need for alternative methods that are faster and less prone to human errors. Machine learning (ML) models have shown great promise in this field, especially with the availability of high-resolution magnetic resonance imaging (MRI) data. However, most of these models do not explain how they make decisions or what features they use for classification. This poses a challenge for trustworthiness and clinical applicability of these models, as clinicians need to understand the rationale behind the diagnosis.

Methodology

Multiparametric MRI images, including T2-weighted, diffusion weighted, and apparent diffusion coefficient modalities from the SPIE-AAPM-NCI Prostate MR Classification Challenge dataset were collected. The images were separated into clinically significant and insignificant prostate cancer classes based on labels. The multiparametric images were then taken through various preprocessing steps which included cropping, co-registration, and standardization to ensure images were in suitable format for the neural network for each class. Sub-volume sampling per MRI study was implemented to overcome limited dataset size. A variant DenseNet model was selected and implemented due to the model's ability to mitigate the gradient vanishing problem. The model was iteratively trained on 528 preprocessed multiparametric images equally split for both classes to ensure high accuracy. Heat maps following prediction were computed ensuring the model provided classification with interpretability.

Results

The model achieved an accuracy of 0.94 on the training set and 0.90 on the validation set with a sensitivity of 0.91 and specificity of 0.89. The model also generated heat maps that showed the areas of the prostate that contributed most to the classification. The heat maps were consistent with the known anatomical locations of prostate cancer lesions.

Conclusion and Impact

This project demonstrates the feasibility and potential of interpretable deep learning models for prostate cancer diagnosis using MRI images. The model not only provides high accuracy, but also explains its decisions by highlighting the relevant features in the input image, enhancing the trustworthiness and clinical applicability of the model, as clinicians can understand the rationale behind the diagnosis. By bridging the gap between accuracy and interpretability, this project offers a pathway for integrating machine learning models into clinical settings. This could improve the early detection and treatment of prostate cancer.

Keywords: Prostate cancer, machine learning, deep learning, interpretability, feature selection

Investigating the Potential of Chemical and Green Approaches for the Production of Kraft Papers from (Musa Paradisiaca) Plantain Peels

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Background

Global usage of plastics is nearly 250 million tons with approximately 42% used in packaging. Wastes generated from the plastic industry are non-degradable and stay in the environment for hundreds of years destroying ecosystems and causing environmental pollution. The negative effects of plastics have led researchers into exploring alternatives such as wood, lignocellulose and agro waste materials for packaging.

Methodology

This work focused on converting peels of unripe plantain into kraft papers. Plantain peel contains 25.7% lignin, 6.8% crude protein, 46.5% cellulose and hemicellulose thus bearing an appreciable amount of cellulose for valorisation. Peels of unripe plantain (Musa paradisiaca) were used to make biodegradable kraft papers by chemical and green methods by employing the soda pulping method and water respectively. Plantain peels were boiled in solutions of 10% and 15% NaOH or water in a 1:2 ratio for 30, 60 and 90 min between 60-70 °C to delignify and separate the fibres. Gelatinous corn starch (5% and 10%) was used as hardener with hydrogen peroxide as a bleaching agent. The efficiency of the delignification process was determined by the UV-spectrophotometer. Grammages, tensile strength and thickness of kraft papers were also determined.

Results

The UV spectra on filtrates from the soda pulping method showed peaks between 260-380 nm, which is indicative of lignin and implied a successful delignification. However, the spectra for water showed no peaks. The characteristics of kraft papers made from the chemical process included grammage of 5-15 GSM, thickness between 0.192- 0.347 mm and tensile strength of 3.518-22.995 N. Alternatively, the sheath from the green process were brittle and weak; the papers could not form well.

Conclusion and Impact

The soda pulping method was effective in delignifying peels of plantain to form kraft papers, which is a good starting material for biodegradable packages.

Keywords: delignification, kraft paper, biodegradable packages, plantain peel, soda pulping.

Design and Evaluation of Diagonal Deep Circulatory Hydroponic System

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Abstract

Present-day agricultural challenges, marked by diminishing cultivable land availability and unpredictable rainfall patterns, poses a growing urgency to create inventive farming techniques. The Diagonal Deep Circulatory (DDC) hydroponic system presents a potential solution to challenges faced by farmers, particularly in regions with limited fertile land and erratic rainfall patterns. This study, conducted at the Agricultural Engineering Workshop of the University of Ghana, aimed to design and evaluate the effectiveness of the DDC hydroponic system using lettuce (Eden variety) as the test crop. The system's construction involved a 0.9m by 0.75m by 1.13m framework comprising five series of 4-inch PVC tubes arranged diagonally and supported by a 5-tier right-angled frame. Each PVC tube was perforated with 7cm diameter holes at 20 cm intervals, accommodating coco peat-filled disposable cups to support plant growth. A 30-liter nutrient solution, circulated by a submersible pump, was channeled through gravity flow, ensuring a consistent nutrient supply without waterlogging. The results obtained over four weeks demonstrated the superior performance of the DDC hydroponic system, showcasing optimal plant growth and minimal instances of algae, fungi, or waterborne diseases. This efficiency suggests the system's potential to address land scarcity and water-related challenges, making it a viable option for enhancing crop yield in adverse agricultural environments. The study recommends the adoption of the DDC hydroponic system to support sustainable crop cultivation and mitigate the impact of land scarcity and drought on agricultural productivity.

***Keywords*:** Diagonal Deep Circulatory; hydroponic system; PVC; optimal plant growth; nutrient solution

Investigating the Hydraulic Retention Time and Cleaning Mechanism of Coconut Biochar Filtration System

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Abstract

Re-purposing wastewater for use in agricultural production is a necessary venture as it creates opportunities to circumvent water shortage situations. Biochar filtration systems use bio-materials mostly biowastes in the environment as an adsorbent to remove pollutants from wastewater. The design characteristics of biochar filtration systems have not been fully explored. Therefore, this study investigated the hydraulic retention time (HRT) and the cleaning mechanism of coconut biochar filtration system. It also tested the efficiency of the system in removing contaminants from wastewater. Two setups of bed thicknesses of 40 cm and 30 cm respectively, were examined under different HRTs. For both setups, the removal of heavy metals (Lead, Pb and copper, Cu) as well as Total Coliform (TC) was very good, but both setups were ineffective in eliminating E. coli.

FTIR analysis showcased the preservation of key functional groups such as hydroxyl and beta diketones (enolic) in the biochar post-filtration, suggesting its sustained adsorption capabilities. SEM imaging revealed the complex surface morphology and diverse pore sizes, which may have contributed to adsorption potential of the biochar. These influenced the cleaning mechanism of the biochar filtration system. This study has implications on farmers and other stakeholders as it informs further research and policy in selecting parameters for the design of biochar filtration systems. This can empower farmers and stakeholders to adopt sustainable filtration practices to address pressing challenges related to water scarcity, water quality, and environmental impact in agriculture.

***Keywords*:** Biochar, Adsorption, Hydraulic Retention Time, Wastewater, Coconut Coir

Comparison of Actual and Predicted Yield of Lettuce Irrigated with Corn Cob Biochar Filtered Wastewater.

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Abstract

This study presents a comparative analysis of actual lettuce crop yields obtained from a field experiment and predicted yields using the AquaCrop model. AquaCrop, is known to be robust in its predictive capabilities in diverse agricultural scenarios, addresses water scarcity and unpredictable climatic conditions impacting agriculture. The study cultivated lettuce in an open environment which is irrigated with wastewater passed through a corn cob biochar filtration system. Key growth parameters, including actual fresh yield (13.46 ton/ha), actual dry yield (1.46 ton/ha), and canopy cover, were carefully monitored. Environmental conditions, encompassing climatic and soil parameters of the experimental site, were coupled with net irrigation requirements and lettuce crop characteristics for input into the AquaCrop model. The model simulated lettuce yield, yielding a predicted fresh yield of 13.55 ton/ha and a predicted dry yield of 1.49 ton/ha. Statistical tests gave a high relationship between AquaCrop's predicted yield and the actual yields, with calculated Root Mean Square Errors (RMSE) of 0.09 for fresh yield and 0.03 for dry yield, affirming the model's reliability. This study confirmed the accuracy of AquaCrop as a predictive tool for lettuce crop yields under similar growing conditions and unveils the viability of employing corn cob biochar-treated wastewater as an alternative irrigation water source. The research typifies a significant step towards addressing the complex challenges of food security and environmental preservation by integrating sustainable water management and precision agriculture.

Keywords: AquaCrop model, water management, sustainable agriculture, crop yield prediction, food security.

Sleep Apnoea Detection Using Machine Learning in Low-Resource Compute Devices and Peripheral Oxygen Saturation Biosensors

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Background

Sleep apnea is a common sleep disorder, set on by the involuntary momentary cessation of breathing during sleep. It is indicative of certain cardiovascular conditions, outside of being a blanket determinant of some defined aspects of sleep quality. It has become necessary to find accessible and inexpensive means of detecting sleep apnea, ergo why this body of work is looking to contribute through the development of a machine learning model for resource constrained computing devices, interfaced with peripheral oxygen saturation (SPO2) biosensors for the detection and classification of sleep apnea.

Methodology

SPO2 recordings of patients with diagnosed sleep apnea that experience desaturation during episodes were acquired from the Dr. Negrín University Hospital. The data is of high dimensionality, with 15000 samples of SPO2 recordings, representing a minute of labelled instances. The high dimensional data under preprocessing was scaled to a unit variance and zero mean using a StandardScaler package. The standardized data was then fed in to a Multilayer Perceptron (MLP) for binary classification, implemented using TensorFlow and Keras. Implementation using TensorFlow allows for the optimization of the final model in to a TensorFlow-lite (tflite) model through quantization and pruning, for use as a low-latency inference API in low-compute devices. The standardization of data before feeding forward in to an MLP proved to be a positive in terms of model accuracy.

Results

A naïve MLP without hyperparameter tuning resulted in a validation accuracy between 75 and 79% on test data. This compares closely to other state-of-the-art classification models for sleep apnea classification which use respiratory data. The original h5 file storing the model configurations and weights was 11MB. Normal model conversion to a tflite resulted in a 1.8MB file size. Further optimization before conversion resulted in a tflite model of file size 470KB, whose binary file can easily run on a low resource microcontroller as an inference API.

Conclusion and Impact

It is possible to train machine learning models for microcontrollers and other low resourced computing devices that can be interfaced with biosensors to be used in sleep apnea detection and classification. Sleep apnea detection and management processes stands to be improved through this method, reducing the need for expensive overnight polysomnography studies. The accessibility of this method through low cost, low resource computing devices allows for the development of other management processes, such as alert systems for sleeping subject in times of severe apnea. The use of non-respiratory data which may also be representative of sleep apnea presence may be used, ensembled with this method, to better improve results' validity.

***Keywords*:** SPO2, Microcontroller, TensorFlow, Multilayer Perceptron, Quantization.

Evaluation of Pressure Compensating Drip Emitters Fitted in a Polyvinyl Chloride Pipe

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Abstract

Evaluating the effect of pressure head on the water distribution uniformity in a polyvinyl chloride (PVC) drip irrigation system is important in irrigation water management and could serve as the basis for optimizing water use efficiency and improving crop productivity. This laboratory study was to evaluate pressure compensating (PC) drip emitters fitted in a PVC pipe. A 6.00m length PVC pipe with five selected randomized emitter points on each lateral were considered for five (5) different operating pressure heads (OPH) (1.60, 1.40, 1.20, 1.00, and 0.80m) at 10, 20, and 30minutes dripping interval and was repeated three (3) times each. PC drip emitters used in this study had a design or manufacturing discharge rate of 10L/h and a 3/4mm emitter diameter at an emitter interval of 0.35m for corn planting specification. Uniformity Coefficient (UC) values for all OPHs were above 90% and classified as excellent based on criteria for assessing drip irrigation system. Emission Uniformity (EU) values decreased as OPH was reduced. Low *EU* values showed that OPHs of 1.00m and 0.80m were highly unrecommendable for the adoption of PVC drip irrigation systems. Larger values for average emitter discharge (Qvar) were obtained as OPH was reduced. Larger *Qvar* values proves unacceptable drip emitter characteristics. Flow variations is essentially kept minimum as the OPH is increased. With the exception of the 1.60m OPH, the coefficient of variation (CV) for all OPHs was unsatisfactory. As a result, the 1.60m OPH is recommended over the other OPHs considering the lateral length in the study.

***Keywords*:** Pressure compensating; drip emitters; operating pressure head; polyvinyl chloride

Intrusion Detection in Smart Energy Meters Using Machine Learning Techniques

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Background

In recent years, the adoption of Advanced Metering Infrastructure (AMI) systems in the energy sector has seen significant growth. These systems typically comprise smart meters, data management software, and communication networks, enabling in-depth analysis of energy usage and efficient data transmission. However, the resource constraints inherent in AMI systems, including limited memory and power, pose a substantial challenge when it comes to implementing conventional security measures. This has raised concerns about the vulnerability of these systems to cybersecurity risks.

Methodology

In this study, we investigate the application of machine learning to secure AMI networks. Our proposed solution centers around a Multi-layer Artificial Neural Network (ANN) model, designed to be both efficient and lightweight, serving as an Intrusion Detection System (IDS) for AMI networks. To develop and train this multi-layer neural network model, we used a network simulation dataset sourced from Kaggle.com. The initial phase of this process involved pre-processing the dataset, focusing on cleaning it to eliminate any outliers and missing entries. Following this data pre-preprocessing stage, we divided the dataset into two parts, with a 7:3 ratio allocated for training and testing, respectively. The ANN model is trained using the training part of the dataset and was subsequently evaluated using the testing part. The resultant model was saved for further analysis, with performance assessments carried out using standardized metrics.

Results

The Artificial Neural Network (ANN) model as an Intrusion Detection System (IDS) yielded remarkable outcomes, with a striking 92.89% accuracy rate and an impressive F1 score of 95.45%. Moreover, the model exhibited exceptional precision and recall scores, both reaching 97.95% and 96.05%, respectively. Notably, the overall size of this IDS solution, at approximately 20 megabytes, underscores its lightweight and highly portable nature, making it an ideal fit for resource-constrained systems. This IDS was effectively integrated into an AMI network, successfully preventing threats such as Denial of Service (DoS) and Distributed Denial of Service (DDoS) attacks launched against it.

Conclusion and Impact

In this work, the application of machine learning as an IDS on AMI networks has been investigated. An IDS is designed using artificial neural networks to safeguard AMI network against threats like Denial of Service (DoS) and Distributed Denial of Service (DDoS) attacks.

***Keywords*:** Intrusion Detection System, Machine Learning, Artificial Neural Networks, Advanced Metering Infrastructure, Computer Network Security

Valorisation of Agricultural Residues for Sustainable Production of Biochar – An Approach for Carbon Sequestration and Environmental Remediation

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Background

The increasing demand for energy, food and other resources due to population increase has contributed to the over-exploitation of the world's natural resources leading to the current environmental problems and the adverse effect of global warming and its associated climate change. Biochar has been identified to be the best means of carbon sequestration as a climate mitigation strategy; a sustainable means of addressing waste management challenges; soil and other environmental remediation; generation of heat and power as renewable energy; utilisation in energy storage technologies; application in catalysis, and building materials, and enhancing circular bio-economy strategies.

Methodology

The study investigated the production and characterisation of biochar produced from three agricultural residues (bamboo, coconut husk shells and palm kernel shells) using a newly constructed innovative and multifunctional plant for pyrolysis, gasification and combustion. The three feedstocks were sorted, resized and preweighed in specimen containers before the pyrolysis. The pyrolysis reaction was done at 5000C for a residence time of 22 hours. The samples were quenched rapidly with clean filtered water, sorted and dried at room temperature until consistent masses were obtained for analysis.

Results

The percentage yields of the biochars produced were consistent with literature figures. Significant amounts of fixed carbons have been sequestered during the slow pyrolysis reaction, with the palm kernel shell having the highest fixed carbon (67.97wt.%), followed by coconut husk shell (67.09wt.%) and bamboo (66.54wt.%). There was also a drastic reduction in the atomic ratios of H/C and O/C. The results further show a substantial surface area presence in the biochars with the palm kernel shell having the highest surface area (377.43 m2/g). Similarly, the palm kernel shell and the coconut husk shell have also pore volumes of 0.16 cm3/g and 0.12 cm3/g respectively which are consistent with similar results documented in the literature. The presence of the microscopic surface areas and pore volumes are relevant in the water and nutrient adsorption capabilities of the biochars.

Conclusion and Impact

This investigation has established that sustainable pyrolysis of such agricultural residues using the newly constructed plant into biochar is a viable means of mitigating climate change-related challenges through carbon sequestration and improving soil fertility by applying biochar for soil remediation actions. Also, the analysis established that the fixed carbons in the biochar are very stable, and the feedstocks and their respective biochars have no detectable sulphur presence. The unique characteristics of the biochars confirmed their utilisation in various applications.

***Keywords*:** Agricultural Residues, Biochar, Carbon Sequestration, Circular Economy, Slow Pyrolysis

Environmental Conditions Monitoring System for Greenhouses in Rural Africa using LoRa Technology

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Background

Due to climate change, food security in developing countries keeps dwindling as farmers incessantly lose several kilograms of produce per year because of unpredictable weather conditions. To palliate to that, some agencies and organizations have taken a bold step to establish greenhouse farming in rural Africa. However, the deployment of sophisticated environmental conditions monitoring systems for these greenhouses in rural Africa faces significant obstacles due to scarcity of electricity and internet connectivity. Thus, the need for a less power consuming and cost-effective monitoring system that does not rely on internet connectivity for data transmission.

Methodology

This project suggests a low-cost and less power-consuming approach using LoRa to monitor temperature and humidity in the greenhouse via a peer-to-peer channel consisting of a node sensor and a receiving node. In a scenario where the farmer has access to internet connectivity at the receiving node, the data received is later transmitted to the farmer's devices using the Message Queuing Telemetry Transport technology.

Results

Results in this project show promising achievement in low-cost greenhouse monitoring systems in rural Africa. The LoRa based sensor node was able to send temperature and humidity information of the greenhouse every ten seconds to the receiving node located 500 meters from the sensor node. This data was later sent to the farmer's device regardless of his location using MQQT.

Conclusion and Impact

This project suggested a low-cost and less power-consuming environmental conditions monitoring system for greenhouses in rural Africa. Results show success in transmitting greenhouse environmental conditions data to the farmer's end. Environmental conditions data are sine qua non to the greenhouse farmer. This helps him make informed decisions which will subsequently lead to an increase in crop yield.

Keywords: *LoRa, low-cost, greenhouse farming, rural Africa, food security*

Building Energy-Efficient Wireless Sensors to Monitor Crop Growth and Conserve Energy Using K-Means Algorithm

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Background
Wireless Sensor Networks (WSNs) have emerged as the pivotal technology for environmental data collection. Their application in agriculture offers real-time monitoring capabilities of soil parameters such as moisture, temperature and humidity. This capability holds promise for enhancing crop yield. WSNs, while indispensable for data collection, often face energy constraints, necessitating mechanisms to conserve energy within the network. This research project addresses a significant challenge of the energy efficiency of WSNs, especially in remote deployments.

Methodology
The network architecture incorporates ATMEGA328P microcontrollers, ESP32 microcontrollers, and NRF communication modules, along with cluster head nodes for efficient data routing. The K-Means algorithm is strategically used to meet the main goal of energy conservation. By allowing sensor clustering based on geographic proximity, this technique improved data transmissions. Data collection was done rigorously during both the rainy and dry seasons.

Results
Conclusions were drawn regarding the season in which the crop performs better, alongside factors contributing to this performance differential. Extensive evaluations conducted under the varying seasonal conditions (Dry and Wet seasons) affirm the system's ability to monitor crop growth effectively while concurrently minimizing energy consumption.

Conclusion and Impact
It was observed that the lifespan of the network was prolonged when it was deployed. Beyond its application in agriculture, the system demonstrates the potential for broader applications in environmental monitoring, fostering sustainability in the related field of agriculture.

Keywords: Wireless Sensor Network – WSN

Automated Detection and Labelling of Lanes in Gel Electrophoresis Images

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Background

Labelling of lanes in gel electrophoresis images is the first step that precedes biological data analysis after gel images are obtained. Owing to lane distortions, band deformities and big data, precise interpretation and annotation of these lanes and bands can be laborious and may delay subsequent investigations. This project aims at expediting big data analysis by automating the detection and labelling of lanes in 96 well-plate gel electrophoresis images.

Methodology

Image preprocessing and object detection were performed to prepare images for subsequent processing and to detect bands respectively using open cv library. Bounding boxes were generated around the detected bands to obtain their dimensions. The least x and y coordinates of the boxes were considered the first and last ladders. The number of lanes were then computed from the distance between the ladders. Labels were finally assigned to detected lanes.

Results

This algorithm was tested on twenty-four gel electrophoresis images, twelve of the images had lane widths of 9 and 10 whilst the remaining twelve had broader widths. The results showed that the algorithm worked best on the images with lane widths of 9 and 10 as it correctly labelled almost all of such images with a performance score of 83%. Conversely, it failed to label images with broader widths.

Conclusion and Impact

This algorithm may be improved upon to serve as an automated tool to assist scientists in labelling gel electrophoresis images of different lane widths, thus saving time.

Keywords: Gel electrophoresis, lanes, bands, big data, Open CV

Detection and Monitoring of Energy Theft Using Customer Consumption Patterns and Machine Learning for Electricity Utilities

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Background

Electricity is one of the most extensively utilized forms of energy, powering a variety of electronic devices. Electricity theft poses a significant challenge to power distribution companies, leading to substantial revenue losses. In Ghana, for instance, the Electricity Company of Ghana (ECG) reported millions of cedis in annual losses, with energy theft being a major contributor. These losses can be attributed to various factors, including technical losses related to energy dissipation during transmission and distribution, non-technical losses primarily associated with energy theft, non-payments, and faulty meters, and operational inefficiencies. This problem is not unique to Ghana, as electricity theft affects power utilities globally. Consumers employ various methods to engage in illicit energy usage, including meter tampering and bypassing, leading to commercial losses and an adverse impact on the overall electricity supply chain. To combat energy theft, utilities worldwide have sought innovative solutions.

Methodology:

To address this challenge, an innovative energy theft detection system has been devised, powered by an ensemble machine learning model. This model combines the strengths of a K-Nearest Neighbors (KNN) algorithm and a Random Forest (RF) model. Training this ensemble model involved utilizing a dataset generated by referencing a public dataset released by the State Grid China Corporation (SGCC). The model is incorporated into a web application that allows users to access a database of different consumers' consumption records. After selecting a record, the user can employ the ML model to analyze the consumption patterns in the record to detect any suspicious activity. The model compares current consumption to previous average consumption and flags significant dips in consumption for extended periods.

Results:

The experiment tested for the detection of energy theft using a range of simulated customer usage data. Each customer's record was based on their three-month energy usage. The system used each customer's consumption records to make predictions. The system performed well in both normal and suspicious usage instances, with average detection accuracy of 98.0% and 98.7%, respectively. Customers who are suspected of using electricity illegally are flagged, and the utility is informed.

Conclusion and Impact:

With machine learning techniques, users' energy use can be tracked based on usage patterns to identify potential instances of illicit electricity use without having to physically visit the location. This solution will help utilities rapidly identify customers and proceed with further checks for remedial actions. Moreover, the solution will help reduce commercial losses and improve the quality of service.

***Keywords*:** Energy Theft, Machine Learning, Artificial Intelligence, Sustainability

Design of a Forward Converter for a Residual Number System Based on the Moduli Set {2N-1,2N, 2N+1}

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Background
RNS as a domain of arithmetics has the potential to be used in the implementation of fast processing units because of the absence of carry propagation. As a result, it is being researched and studied for use in applications that require ultra-fast speed and parallel processing like digital signal processing, digital image processing and cryptograph.This paper focuses on the special moduli set {2N - 1, 2N, 2N + 1} to advocate an approach to converting binary numbers to residue numbers and its hardware implementations.

Methodology
Forward converter design for moduli set {2N - 1, 2N, 2N + 1}
The input value fed into the converter has a word size of 3***N** bits and it is grouped into three n-bit blocks. For example, if **N**=4, the three blocks will be 4 bits each and the input bits will be **12 bits**.The three n-bit blocks are denoted by their decimal representations denoted as **B2**, **B1**, and **B0** where **B0** is the decimal representation of the rightmost n bits, **B1** is the representation of the middle n bits and **B2** a representation of the leftmost n bits. The modular design methodology was adopted as follows.

2N – 1 unit

Residue relative to 2n-1 = R2n-1 = |B2 + B1 + B0|2n-1This implies the design of a mod 2n-1 adder.

2N unit

Deriving the modulo 2n result follows a straightforward approach and it is simply B0.

2N + 1 unit

Residue relative to 2n+1 = R2n+1 = |B2 - B1 + B0|2n+1 This implies the design of a mod 2n+1 adder.

Putting All Together

The Datapath for 2N-1, 2N and 2N+1 in this paper is based on the case study when **N**= 3, that is the moduli set used is {7, 8, 9}. The elements for performing the modulo additions and subtractions are put together to derive the data path for the converter. The design work is completed with the design of a control unit. Hardware description was done in VHDL. Specific design for n=3 was modelled followed by the derivation of a generic model using n as the parameter. After RTL simulations to verify the design for various n values, it was implemented on an FPGA after post-synthesis analysis. The system operates well at 130 MHz

Results
The proposed forward converter is capable of conversion from decimal to RNS, based on the value of **n.** The frequency of operation is independent of the value of n.

Conclusion and Impact
We focused on the forward converter and proposed a generic approach for converting numbers from the binary representation to the residue representation base on the moduli set {2N-1, 2N, 2N + 1}. This serves as a frame work on which RNS processors maybe designed to take advantage of fast arithmetic in RNS.

***Keywords*:** Residue Number System (RNS), Forward Converter, Moduli Set, Dynamic Range, Chinese Remainder Theorem (CRT)

Developing a Robust Web-Based Breast Tumour Classifier using Machine Learning

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Background

Breast cancer, a significant concern among women, requires early detection to improvesurvival rates. Fine Needle Aspiration Cytology is one of the prominent ways to detectcancerous tumours and it solely depends on the intervention of the breast cancer specialist which poses a challenge upon accuracy of detection. The necessity for a highly accurate breast tumour classification tool has been a major concern in recent years. This deficiency highlights the critical need to achieve early diagnosis, implementpersonalized treatment plans rapidly, and increase the success rate in combating breast cancer-related deaths. This project aims to address this issue by developing a web application that utilizes machine learning for breast cancer diagnosis, specifically leveraging computed values from fine needle aspiration (FNA) images. Furthermore, incorporating a database system would provide an efficient way to store patient records and serve as a hub fordata in subsequent training of the model.

Methodology

The project utilizes the Wisconsin Breast Cancer Database, containing real-world features computed from microscopic images of Fine Needle Aspiration Biopsy. The dataset was carefully processed to eliminate missing data and ensure data accuracy. Feature selection was performed using visualization techniques, including swarm plot, violin plot, and correlation heatmap, resulting in the identification of 16 relevant features out of the initial 30 features. Three machine learning models, including LogisticRegression, Random Forest, and XGBoost, were trained and evaluated on the dataset, and the Streamlit framework was employed to create the end application for userinteraction, coupled with MySQL for the database.

Results

Based on accuracy, precision, F1-score, and recall as evaluation metrics, XGBoostemerged as the best model, averaging 0.97±0.01 (accuracy), 0.96±0.01 (precision),0.97±0.01 (F1-score), and 0.97 (Recall) for both benign and malignant prediction performance. The model was subsequently integrated into the web application built withthe Streamlit library. The application allows for input of values based on the features, providing predictive analysis indicating whether the tumour is benign or malignant, alongwith a confidence score.

Conclusion and Impact

This project demonstrates the power of machine learning in healthcare, specifically inthe early detection and classification of breast cancer. The resulting web application serves as a potentially useful tool for healthcare professionals, aiding in the more robustand faster detection of cancerous breast tumours.

***Keywords*:** Tumour, Benign, Malignant**,** Fine Needle Aspiration Cytology (FNAC),Machine Learning

Development of a Handheld Device for Diagnosis of *Candida Albicans*

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Background

Infection of individuals by invasive candidiasis remains a glaring issue in community healthcare. Prevalent *Candida* diagnostic methods based on plate culture require long periods of time of up to 4 days to identify *Candida* species present in samples in spite of numerous medical advancements and technological progress, the development of compact and portable point-of-care diagnostics for expeditious and detailed testing and detection continues to pose a challenge. This project proposes the systematic development of a handheld digital device tailored for the detection of invasive *Candida albicans*. Employing a fusion of lateral flow immunoassay (LFIA) technology, advanced sensors, and intuitive user interfaces, this device signals a paradigm shift in medical diagnosis with the potential to reshape patient care. This project puts to use already existing pH strips and advanced sensors to detect presence of *Candida* based on capturing and analysing resulting images of samples subjected to a lateral flow immunoassay test. This endeavour acknowledges the imperative for transformation in the face of persistent challenges. Conventional diagnostics, rooted in established methodologies, grapple with temporal issues and potential precision issues. In response, an interdisciplinary diagnostic device endeavours to surmount current challenges by harnessing LFIA and advanced optical sensing mechanisms.

Methodology

Project planning and objective setting: The goals of the lateral flow immunoassay test kit are defined. Project members then determine the intended use, target demographic for testing purposes, and also discuss desired outcomes.
Literature review: Existing literature on lateral flow immunoassay, the use of optical sensors in medical diagnosis will be extensively reviewed. Also, literature on *Candida albicans* diagnosis will be researched. This is to aid in understanding principles, technologies and best practices involved in this study.
Design and Development: Selection of specific antibodies or antigens, conjugate particles, sample preparation methods, and test strip design will be discussed and agreed upon. Subsequent changes may occur based on advancements in literature review.
Prototyping: Prototypes of the test kit will be assembled. This includes sourcing of various electrical components and assembly of said components into a functional device.
Validation and Verification: Laboratory testing to validate the performance and accuracy of the LFIA test kit will be conducted. Verification of its sensitivity, specificity and overall accuracy in detecting *Candida albicans* will be recorded for data collection purposes.
Seek Regulatory Compliance: Compliance of the test kit with relevant regulatory and quality standards will be ensured. Ethical clearance will also be applied for in order to ensure compliance with ethical codes as pertains to human testing. Testing of device, data collection, and analysis: The LFIA test kit will be subjected to human testing. Data collection procedures will be implemented to monitor the kit's real-world performance and user feedback. The data will then be analysed for continuous improvement.

Results

1. High specificity and sensitivity for *Candida albicans* detection: The test kit should
2. accurately identify the presence of *Candida albicans* in clinical samples while minimizing false positives and false negatives.
3. Reliable performance of diagnosis: The test kit should be able to consistently produce accurate results across different sample types.
4. Rapid detection of candidiasis: The test kit should provide quick results, allowing for timely medical diagnosis.
5. Reduction in diagnostic time: A shorter time for diagnosis, which can lead to faster treatment and improved patient outcomes.
6. Improved public health: A contribution to improvement in public health by reducing the prevalence and impact of invasive *Candida albicans* infections.

Conclusion and Impact

In culmination, this project intertwines medical insight, technological innovation, and academic dedication to craft a handheld diagnostic device for invasive *Candida albicans* infections. The strategic fusion of lateral flow immunoassay (LFIA) technology and advanced optical sensing heralds a new era in diagnostics—a future where swift and precise identification of infections is realised. Beyond technical achievements, this project embodies the promise of healthcare transformation. By expediting accurate diagnosis and tailored interventions, it holds the potential to alleviate patient distress and elevate healthcare standards. As it transcends academia, this project stands as a beacon of innovation, illuminating a path towards improved healthcare outcomes in the imminent horizon.

***Keywords*:** Candidiasis, *Candida albicans*, LFIA, Diagnosis, Healthcare

Natural Product-based Inhibition of Phospholipase A2 in the Venom of West African Carpet Viper *Echis ocellatus*

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Background

Echis ocellatus envenoming kills more than 20,000 people annually in Sub-Saharan Africa. Current anti-venoms utilized in treatment are ineffective, expensive, and trigger adverse reactions in some victims, hence becoming a therapeutic challenge. Plant-based natural compounds have emerged as promising alternatives in the pursuit of effective anti-envenomation drugs. The diverse effects of acidic phospholipase A2 (PLA2) in *Echis ocellatus'* venom present an opportunity for inhibition and eventual drug discovery. The study focused on predicting potential inhibitors of PLA2 from the phytochemicals notable for treating snakebites traditionally.

Methodology

A library of 380 natural compounds was constructed and further filtered using physicochemical profiling. The remaining compounds were docked against the homology-modelled structure of PLA2. Novel structural insights into the binding mechanisms were elucidated using LigPlot+ and molecular dynamics simulations.

Results

Five bioactive compounds with PubChem CIDs 442879, 65752, 72307, 156516 and 160502 with binding energies of -8.7, -8.2, -7.6, -7.8 and -7.8 respectively were identified as potential leads with relatively good binding energies below the threshold of -7.6kcal/mol. They were shown to possess reasonably good pharmacological profiles with insignificant toxicities. Biological activity prediction revealed relevant properties as cytoprotection and hepatoprotection.

Conclusion

The compounds are recommended for further experimental evaluation as potential biotherapeutic agents for snake envenomation.

Keywords: *Echis ocellatus,* Envenomation, Anti-Venom, Natural Compounds, Bioactive molecules.

Investigating the Efficacy of Zeolite-Chitosan Composite and Synthetic Zeolite as Potential Nanocarriers of Chemotherapeutic Drugs to Breast Cancer Cells

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Background

Breast cancer has the highest prevalence & mortality rate amongst women in Ghana, Africa and globally. Due to the adverse side effects associated with the traditional chemotherapy, scientists are exploring the avenue of targeted controlled drug delivery using nanoparticles.

Methodology

A composite of zeolite and chitosan was synthesized and dried and FTIR characterization was done. A stock solution of Doxorubicin drug was prepared and ten serial dilutions were performed to obtain ten different concentrations ranging from (0.2mg/ml - 2 mg/ml). The different drug concentrations were uploaded onto zeolite and zeolite-chitosan composite nanoparticles using the entrapment method. The upload behavior of the materials was studied and then the loading capacity of each material was determined. Release kinetics of the two materials were studied in three different pH media (5.0, 6.5 and 7.0). The release kinetics data was fitted onto mathematical models. The loaded nanoparticles were used to treat MDA-MB-468 breast cancer cells for a period of 72 hours and the cytotoxicity of the loaded nanoparticles was evaluated.

Results

The upload studies revealed that zeolite had a higher loading capacity than the composite. The release kinetics results showed pH 6.5 to be the optimum media for drug release from the nanoparticles. The zeolite-chitosan composite also demonstrated a more steady and controlled release as compared to zeolite. Cellular studies revealed that higher drug concentrations of loaded zeolite were more efficient in killing the cells after 48 hours. The zeolite-chitosan composite demonstrated a reverse cytotoxicity trend. Lower concentrations of loaded zeolite-chitosan composite were more efficient in killing the cells after 72 hours while some higher concentrations appeared to cause proliferation of the cells.

Conclusion and Impact

The result from the study demonstrates the potential of zeolite-chitosan composite and synthetic zeolite to be used as nanocarriers. Targeted drug delivery using these nanocarriers have the potential to improve cancer treatment and reduce side effects associated with traditional chemotherapy.

Keywords: breast cancer, nanoparticles, cytotoxicity, release kinetics, targeted drug delivery.

Determining Baseline Thoracic Kyphosis Angle Among Ghanaian Adults Using Radiograph Technique for Clinical Application

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Background
Thoracic back pain (TBP) is a type of discomfort that manifests in the thoracic spine, which is situated at the rear of the chest or thorax, predominantly between the shoulder blades. This region of the spine extends from the lower part of the neck to the beginning of the lumbar spine, approximately around the waist. Literature shows that about 60% of Ghanaians suffer from back pain. Limited information is known about the baseline dataset of thoracic kyphosis angles for the Ghanaian population and how they relate to hyperkyphosis.

Objective
To establish local reference values for the thoracic kyphosis angle of the healthy Ghanaian population.

Methodology
A retrospective study design approach will be used in this study. The purposive technique will be used to select the normal radiographic image of the upper thoracic spine image when pronounced normal by the radiographer. The radiographic image of the thoracic spine will be obtained using x-ray equipment. Patients will be positioned in a standardized manner to ensure consistency in imaging. The patient's thoracic region will be identified with specific anatomical landmarks on the radiograph. The thoracic kyphosis angle will be measured between two key points:

- The superior endplate of the first thoracic vertebra (T1)
- The inferior endplate of the twelfth thoracic vertebra (T12)

The angle between these two points will determine the kyphosis angle according to Cobb's method. This research project aims to gather data on the lateral thoracic kyphosis (TK) of 150 participants aged 18 years and above.

Expected outcome
The study is expected to produce the baseline data for the analysis of thoracic kyphosis angle within the Ghanaian population. This study is expected to make a valuable contribution to the existing body of knowledge in the field of research concerning the precise range of kyphosis angles that should be considered for both diagnosis and treatment of thoracic curvature.

Conclusion and Impact
If successful, this study will help reduce the likelihood of diagnostic errors in upper back pain by shifting from a subjective way of providing treatment for patients thoracic curvature.

***Keywords*:** Radiographic, thoracic angle, thoracic kyphosis, upper back pain, anatomical**.**

Lecture Hall and Office Monitoring System Using Access Control

Abstract

In an era marked by rapid technological advancements, the imperative for efficient and secure access control systems within educational institutions and office environments cannot be overstated. Access control systems play a pivotal role in ensuring security and managing authorized access to both physical and digital resources. This research project presents the design, development, and implementation of a Lecture and Office Monitoring System, strategically incorporating a fusion of access control methods including biometric fingerprint recognition, RFID card authentication, and PIN/password verification. The convergence of these complementary systems mitigates the limitations inherent in each, culminating in the establishment of a resilient and user-friendly hybrid solution.

The paramount aim of this system is to augment security, streamline access management, and furnish invaluable insights into user attendance and behavior. Leveraging biometric fingerprint recognition guarantees secure and individualized identification of users, while RFID card authentication optimizes convenience. The inclusion of PIN/password verification adds an extra layer of security to the system's architecture.

The system harnesses contemporary database technologies to meticulously record and manage access events, thereby enabling real-time monitoring of lecture halls and office spaces. Furthermore, it offers an intuitive interface catering to both administrators and end-users, facilitating seamless enrollment, access provisioning, and report generation. The amalgamation of these access control modalities serves to establish a multi-tiered security framework, reinforcing the dependability of the entire access control system.

Throughout the course of this study, rigorous assessments encompassing extensive testing and user feedback were conducted to evaluate the system's performance and efficacy. The results unequivocally demonstrate substantial enhancements in security, attendance tracking, and overall access management efficiency.

This project transcends immediate security and access control requisites, positioning itself as a foundation for prospective enhancements and potential integration with other systems. The Lecture and Office Monitoring System, distinguished by its multifaceted access control mechanisms, signifies a pivotal stride toward safeguarding the welfare and productivity of educational and office environments in the digital era.

Development of Smart Per Capita Energy Meter

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Background
Smart Energy Meter is an automated billing meter that measures and record the per capita electricity consumption in residential and commercial buildings. This meter offers real-time data on energy usage, enabling consumers to monitor and adjust their consumption. However, in Ghana, not all apartments have energy meters due to inadequate energy meters from the power distribution companies leading to disputes among tenants sharing electricity bills. We have developed a user-friendly smart energy meter to resolve disputes among tenants in compound houses.

Methodology
The meter uses current and voltage sensors to measure voltage and current at user's end to determine the power and energy consumed in kilo watt-hour. This data is transmitted wirelessly to a database where energy consumption data in kilo-watt-hour is calculated and converted into a local currency (GHC). The meter also displays current (I), voltage (V), power (W), energy (kWh), frequency (Hz) power factor (PF) and amount of energy consumed in Ghana cedis on its LCD display. All the above-mentioned parameters will be updated automatically when there is a change in tariff.

Results
The smart energy meter has been tested in a house and it yielded good results in calculating the per ca-pita power consumed and converting it to Ghana cedis. A prototype meter has been produced for demonstration purposes.

Conclusion and Impact
The main goal of this work is to develop a working system that could provide accurate meter readings and displays of the user's electrical consumption in price units. The energy consumption has been monitored in this system, and the data has been stored in the Arduino, preventing data loss. The information is then used to calculate the exact amount of energy used in the unit of a kilowatt-hour (kWh) and then converted to Ghana cedis. The impact of the smart energy meter is solving tenant quarrels in tenant houses promoting peaceful coexistence in the tenant houses, solving the persisting issue of meter shortages in the country, and creating job opportunities.

***Keywords*:** Smart energy meter; shared meter; kilo-watt-hour (kWh); per ca-pita consumption

Folic Acid Conjugated Bacterial Cellulose Hydrogels Loaded with Cyclodextrins for the Delivery of Anticancer Drugs

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Abstract

The aim of this study is to generate a polymeric drug carrier made of Bacterial Cellulose and β-cyclodextrin, conjugate it with Folic Acid and characterize it. This drug carrier should have a potential for the association and delivery of hydrophilic and hydrophobic drugs for a targeted delivery especially in cancer therapy.

In the synthesis of the drug carrier, mono(6-(2-aminoethyl)amino-6-deoxy)-b-cyclodextrin is first conjugated to folic acid via the NHS/DCC) conjugation chemistry. Curcumin is then loaded into the cyclodextrin to form the curcumin folic acid conjugated cyclodextrin inclusion complex. The inclusion complex is loaded into bacteria cellulose pellicles by both in situ and ex situ techniques.

The synthesized folic conjugated bacteria cellulose hydrogels loaded with cyclodextrins are characterized using SEM analysis, FTIR spectrometry and XRD analysis. Drug loading, encapsulation, cell uptake and drug release studies as well as cytotoxicity tests are carried out on the carrier using MCF-7, MDA MA-231, pancreatic cancer and mouse fibroblast cell lines.

The resulting carrier is expected to have an appropriate shape and size. Curcumin is expected to loaded in the generated carrier and have a high encapsulation efficiency. In vitro drug release studies of curcumin from the drug carrier is expected to be sustained and the antitumor activity of the drug carrier higher in cancer cells than normal cell lines.

Identification of Potential Inhibitors of N-Acetylglucosamine-1-Phosphate Transferase in Mycobacterium Tuberculosis Using Molecular Docking Studies

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Background

Tuberculosis (TB) remains a significant global health challenge, necessitating the discovery of new and effective medications. Existing first-line TB drugs are prone to drug resistance due to prolonged use, underscoring the urgency to identify novel compounds with potent anti-TB activity. Natural products offer a vast array of chemical structures and possess the ability to modulate disease-related metabolic pathways, leading to improved therapeutic responses. This study employs computational simulations to identify and evaluate potential lead compounds derived from natural products for their inhibitory effects against the N-Acetylglucosmaine-1-Phosphate (NAG1P) enzyme of *Mycobacterium tuberculosis* (Mtb).

Methodology

Through homology modelling, the three-dimensional structure of N-Acetylglucosmaine-1-Phosphate is generated and validated. A virtual screening approach is then employed, evaluating 43,792 compounds from diverse databases against the validated NAG1P model. Docking simulations using AutoDock Vina in Pyrx are performed, and the docking protocol is validated through the computation of a Receiver Operating Characteristic (ROC) curve, yielding an Area Under the Curve (AUC) value of 0.7106273.

Results

Thirty-four hit compounds are identified from the virtual screening, demonstrating strong binding within the active site pocket of the NAG1P receptor. The hit compounds undergo further in-silico bioactivity ad pharmacological profiling. Among them, Assafoetidnol_A, Sigmoidin, and SA_217 emerge as potential leads, displaying favorable binding energies of -10, -9, and -9.2 kcal/mol, respectively. These compounds exhibit promising pharmacological profiles, showing minimal toxicity and drug-like characteristics. Computational analysis indicates their potential biological activities, including antibiotic and antimycobacterial properties.

Conclusion and Impact

These natural products hold significant potential as novel agents against Mtb, with minimal toxic effects, making them promising candidates for further exploration in the treatment of tuberculosis. This research contributes to the field of anti-TB drug discovery by leveraging computational simulations to identify and evaluate compounds with inhibitory potential against the NAG1P enzyme, providing a foundation for future experimental studies and the development of effective anti-TB medications.

***Keywords*:** Tuberculosis; *Mycobacterium tuberculosis* (Mtb); Molecular docking; N-Acetylglucosmaine-1-Phosphate; Drug-like; Natural Products.

Investigating the Effect of Zeolite-Loaded Herbal Mixture on Prostate Cancer Proliferation

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Background

The projected aimed to assess the effectiveness of LTA zeolite (Kibi zeolite) loaded with a herbal blend (containing ginger, garlic, turmeric, cayenne etc.) known for treating kidney-related issues and having potential anticancer properties, on prostate cancer proliferation.

Methodology

The process involved extracting the active ingredient, polyphenol, using ethanol, followed by drug loading experiments with various concentrations (0.2mg/ml, 0.25 mg/ml, 0.33 mg/ml and 0.9 mg/ml). Kibi zeolite of 100mg was added to the concentrations and rotated for 3 hours in intervals of 30 minutes before being centrifuged. The absorbance values were measured to study drug uptake. After 24 hours, absorbance was measured again to analyse the difference in concentration. Drug release experiments were conducted by placing loaded zeolites in a release medium (70% ethanol) and measuring absorbance after rotation of 3 hours in intervals of 30 minutes after rotating at a speed of 11rpm and centrifuging at 6000 rpm at 3 minutes.

Results

Results showed decreasing absorbance over time during drug release, with saturation after 90 minutes due to the display of a plateau in the release graphs. Cellular studies on both cancerous and non-cancerous prostate cells revealed varying viability responses to different concentrations. Notably, 0.25 mg/ml and 0.9 mg/ml concentrations showed significant reduction in cancer cell population.

Conclusion

This experiment confirmed our hypothesis on the herbal blend possessing anti-cancer properties and Kibi zeolite as an effective drug carrier system.

Keywords: Zeolite, Herbal Mixture, Polyphenol, Prostate Cancer, Drug Carrier System

Thermal Effects on the Electrical Conductivity of Polyaniline Polymer

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Abstract

Polyaniline emeraldine salt, an important member of conducting polymers, is well-known for its electrical conductivity and versatile applications. Extensive study has been devoted to improving its electrical conductivity by doping with different chemicals. Both pure polyaniline emeraldine salt (P-ES) and polyaniline emeraldine salt doped with potassium iodate (ES-KIO_3) are examined in this study to determine the effects of temperature on their electrical conductivities. The study examines the thermal effects on P-ES and ES-KIO_3 using a wide range of experimental methods, which include, FTIR, differential scanning calorimetry (DSC), thermogravimetric analysis (TGA), and electrical conductivity studies. The P-ES and its doped equivalent exhibit unique thermal transitions and conductivity variations. These transitions profoundly affect the electrical characteristics of the materials by altering their molecular and crystalline structure, as well as their oxidation state. The ES exhibited a decline in electrical conductivity as temperature increased. This behavior aligns with the concept of enhanced polaron hopping resulting from thermal excitation, contributing to the understanding of temperature-sensitive conductivity in conducting polymers. The introduction of potassium iodate into the ES matrix to create ES-KIO_3 yielded unexpected results-that is, the electrical conductivity of ES-KIO_3 displayed a non-monotonic trend with varying temperatures, indicating a complex interplay between temperature and the doping agent. The conductivity of ES-KIO_3 at 150ºC was relatively higher as compared to P-ES and that could be as a result of the dopant dissociating into its respective ions, thereby increasing number of charge carriers and conductivity. This study makes significant contributions to our understanding of the relationship between temperature and electrical conductivity in both pure and doped polyaniline emeraldine salts, laying the groundwork for the development of materials with customizable electrical characteristics. The research also broadens our understanding of how heat affects conducting polymers and opens up opportunities for improving these materials performance in a variety of cutting-edge technologies and applications.

In silico Identification of Potential Inhibitors Against High-Risk HPV16 e6 Oncoprotein in Cervical Carcinogenesis

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Abstract

High-risk human papillomavirus (HPV) is a major etiological agent for cervical carcinogenesis, reported in more than 95% of all cervical cancer cases. The upregulation of the HPV E6 protein upon viral integration leads to the deregulation of major proteins in the cellular signalling pathway, such as the inhibition of a vital tumour suppressor protein, P53. Despite being a key driver in the progression of HPV-positive cancers, FDA-approved drugs/treatments targeting this protein are lacking, which this study investigated by identifying the binding pockets of HPV E6 protein and screening them for potential inhibitors. AutoDock Vina was used to virtually screen 1085 natural products of African origin, 2 cervical cancer drugs, and 4 known E6 inhibitors against the HPV16 E6. The Receiver Operating Characteristic (ROC) curve's Area Under the Curve (AUC) was used to assess the docking protocol. Protein-ligand binding mechanisms and interactions were characterized using LigPlot+ and molecular dynamics simulation. An algorithm of activity spectrum estimation was used to predict the biological activities of hit compounds obtained. Six top natural compounds were identified, with high binding free energies ranging from -8.7 to -8.4 kcal/mol, the threshold was -8.0 kcal/mol. The compounds were predicted to possess good pharmacological profiles. All six compounds were predicted as antivirals, apoptosis agonists, and anticarcinogenic, while 3 of them were additionally predicted as p53 enhancers. The six compounds therefore have the potential to halt the progression of oncogenesis in HPV-16-positive cervical cancer cells. In-vitro assays to evaluate their efficacies and toxicity are planned with the ultimate goal of developing novel anticancer drugs.

Keywords: Human papillomavirus, HPV16 - E6, p53, Virtual screening, Molecular Dynamics Simulation.

Investigating the Effects of Zeolite and Halloysite Nanoclay on Phosphate Bonded Investment Material

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Background

Zeolites are formed in nature and produced synthetically whiles halloysites are formed in nature. There is a little to no research available that incorporates locally synthesized zeolites and halloysites into investment materials. Investment materials are ceramic materials for forming moulds into which alloys are cast for dental applications such as custom restorations for crowns, inlays and many more to replace missing or damaged teeth. This could help reduce the cost of dental restorations and also improve upon the properties of these investment materials. Zeolites and halloysites are aluminosilicate minerals that belong to the same kaolinite group. Their ion exchange ability, large surface area, pore size and high thermal stability make them suitable in application of dental investment materials. This study investigated the effects locally synthesized zeolite (faujasite) and halloysite nanoclay in phosphate bonded investment material (PBIM).

Methodology

The zeolite synthesis involved thermal activation, cation exchange, aging process, crystallization and filtration process. The faujasite and halloysite were mixed with PBIMs from 0.5-5% to form nanocomposites.

Results

Compressive and hardness tests performed revealed elevated compressive strength values for both halloysite from 0.71 - 0.87 MPa and zeolite nanocomposite from 0.66-0.67 MPa, compared to that of the PBIM of 0.58 MPa. Halloysite nanocomposites again exhibited higher hardness at 5% (~431 leebs) than zeolite nanocomposites at also 5% (~420 leebs) after firing. P-values calculated at 95% confidence level also showed high significance between 0.33-0.94 for halloysites nanocomposites and 0.11-0.98 for zeolite nanocomposites. Halloysites had smaller crystallite sizes ~20.76nm than zeolites ~26.33nm which may influence compressive strength and surface hardness. A positive correlation is observed between compressive strength and surface hardness. TGA revealed high thermal stability for all samples after firing as maximum mass loss recorded was ~0.8%.

Conclusion and impact

Halloysite and zeolite nanocomposites increased the compressive strength of the PBIMs by 76% and 36% respectively. Halloysites and faujasite may be incorporated into PBIMs to improve compressive strength and may possess novel characteristics that may influence its application for dental investments in Ghana and beyond.

***Keywords*:** PBIM, halloysite, faujasite, strength, hardness, nanocomposite

Optimization and Quality Characteristics of Canned Cowpea Bean in Oil

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Abstract

Cooked beans in palm oil, '*gob3*,' is a relished Ghanaian meal prepared with black-eyed cowpea (*Vigna unguiculata*) in palm oil. The hard-to-cook phenomenon of cowpea, which induces prolonged cooking time and high energy consumption, provides an opportunity to process 'gob3' into a ready-to-eat meal to provide convenience for Ghanaian consumers. One of the major challenges of processing 'gob3' into a convenient processed food product is the long-term preservation under ambient conditions without the solidification of the palm oil, which may not be appealing to consumers as a ready-to-eat product. This study focuses on coupling optimisation techniques with food additives to process cowpeas in various formulated palm oil blends into a ready-to-eat canned food product. Three formulated palm oil blends, Frytol in 20% palm oil (F1-2), Sunflower oil in 20% palm oil (S1-2), and 60% palm oil in water as control (C1-6), were analysed. The nutritional content of the canned bean product with three formulated oil blends was observed to have relatively higher nutritional content in terms of energy, carbohydrates and proteins than canned beans in brine as a control. Regarding the solidification of the blended oils, C1-6(60% palm oil) remain liquid under ambient conditions. Further statistical analysis (ANOVA one-way) on sensory evaluation of selected samples' appearance, texture and aroma sensory characteristics at a significance level of $p<0.05$ deemed the aroma characteristic as significant, with the control sample C1-6 (with an orange-yellow oil blend of 89.81°hue angle) scoring the highest mean value showing substantial consumer interest, suggesting high acceptance and marketability of the canned beans in palm oil. Subsequent rancidity tests on all the samples revealed high moisture, high free fatty acids (FFA) and peroxide values, indicating the rancidity and spoilage of the various oil blends. This was due to suboptimal and improper extraction methods during the oil production and unfavourable storage conditions. The study is a step closer to developing and achieving a shelf-stable, ready-to-eat Ghanaian dish 'gob3".

Keywords: *Cowpea, palm oil, canned food.*

Prediction of Agonists for the GLP-1R Using Machine Learning

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Background

The glucagon-like-peptide-1 (GLP-1) receptor, a G protein-coupled receptor (GPCR) on pancreatic beta cells, plays a pivotal role in insulin signaling when activated by its ligand, GLP-1 hormone. Inadequate binding of this ligand to GLP-1 receptors results in diminished insulin production and reduced glucose metabolism. Consequently, the GLP-1 receptor has garnered attention as a therapeutic target for type 2 diabetes (Diabetes Mellitus). To address the deficiency of GLP-1 hormone, agonists were developed experimentally to engage the GLP-1 receptors. In recent years, machine learning has greatly improved the drug discovery process. Previous efforts to predict novel GLP-1 receptor agonists have primarily employed the Support Vector Machine.

Methodology

This study utilized data from ChEMBL (ChEMBL ID 1784) concerning GLP-1R agonists to train and test nine robust machine learning models for predicting the activity level and EC50 values of these compounds. The performance of these models was assessed using ten evaluation metrics for both classification and regression models. Notably, the top-performing model for both classification and regression tasks was the neural network. The CNN predictive model achieved an accuracy of 0.99, a specificity of 1.00, and a sensitivity of 0.99. The Recurrent Neural Network demonstrated an RMSE of 0.01, a determination coefficient of 1.00, and a correlation coefficient of 1.00.

Results

The study's findings underscore the potential of neural networks as highly effective models for drug prediction, excelling in both classification and regression tasks. Neural networks have the capability to capture intricate relationships within numerical data, making them a promising tool for drug discovery.

Conclusion and Impact

In conclusion, this research highlights the significance of the GLP-1 receptor in type 2 diabetes treatment and the development of agonists. Furthermore, it showcases the power of neural networks in enhancing drug discovery, emphasizing their role as valuable tools for classification and regression tasks. These findings have implications for the future of drug development and personalized medicine.

***Keywords*:** Glucagon-like-peptide-1 receptor, Machine learning, Supervised learning, Activators, Classification, Regression, Neural networks, Drug discovery.

Metallurgical Study and Analysis of Ancient Akan Brass Cast Artefacts

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Abstract

This study is about centuries old Akan brass cast artefacts with the aim to understand the composition and their properties. The study is to further understand the processes of the casting processes which can provide valuable insights into the craftsmanship techniques employed by ancient traditional Akan artisans. The study examines five distinct brass casts using techniques such as scanning electron microscopy (SEM), x-ray fluorescence (XRF) analysis, density analysis, electrical conductivity measurements, and hardness testing. The SEM analysis revealed the microstructure of the brass casts and other defects that may have occurred during the casting process. The elemental composition of each brass cast was determined, unveiling variations in copper, zinc, lead, oxygen, and other elements contributing to the unique properties of each cast. The density analysis of the casts showed a variation from 10.69 gcm^{-3} to at 8.61 gcm^{-3}, an indication that the artifacts are brass alloys. The electrical conductivity measurements demonstrates that the resistance increases (ranging from 2 ohms to 10 ohms) across all the brass casts. The hardness test measurements showed variation across all the five brass casts using different scales such as Rockwell, LeeB and Brinell. A combination of these characterization techniques in studying these Akan brass cast artifacts does not only deepen our understanding of their properties but also enrich our understanding of the historical craftsmanship behind these ancient innovations by providing a connection between artistry, cultural heritage, and scientific exploration.

Design and Fabrication of a Tow Tank at Ashesi University for Hydrodynamic Experiments

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Ashesi University

Abstract

The design and fabrication of a tow tank at Ashesi University is presented, with a primary focus on conducting hydrodynamic experiments to measure drag and lift forces induced around various objects. The tow tank consists of four key subsystems: the drive system(motors, drivers, and drive mechanisms), force sensing(lift and drag), the tow system, and a MATLAB-based control application. The purpose of this tow tank is to bridge the gap between theoretical concepts taught in the classroom and their real-life applications, as well as to facilitate cutting-edge research in hydrodynamics.

The drive system of the tow tank provides a means to control the speed and direction of the towing mechanism, allowing precise and repeatable testing conditions. The tow system, on the other hand, is responsible for securing and towing the object under investigation through the water in a controlled manner. These subsystems work in tandem to create a controlled environment in which hydrodynamic forces can be accurately measured and analyzed.

The MATLAB-based control application enhances the versatility of the tow tank by enabling automated control of the entire experimental process. This includes setting towing speeds, recording data, and conducting post-experiment data analysis. It offers a user-friendly interface for researchers and students to operate the tow tank efficiently and extract valuable insights from the experimental results.

The significance of the tow tank at Ashesi University extends beyond the confines of the laboratory. It acts as a bridge between theoretical learning and practical application, offering students a hands-on experience to better understand the complexities of fluid dynamics and hydrodynamics. This, in turn, nurtures a more skilled and industry-ready workforce in fields such as naval architecture, marine engineering, and offshore technology if students decide to pursue them.

Moreover, the tow tank opens new avenues for research in hydrodynamic products. Researchers can use this facility to study the behavior of ships, underwater vehicles, and various marine structures, thereby contributing to advancements in design, efficiency, and safety in the maritime industry. The acquired data from these experiments can have implications for the development of more hydrodynamic, fuel-efficient vessels and structures.

In conclusion, the design and fabrication of the tow tank at Ashesi University marks a significant step in advancing the field of hydrodynamics, providing a valuable resource for education and research. It not only empowers students with practical skills but also offers a platform for innovative studies in hydrodynamic products, ultimately contributing to technological advancements in the maritime, aerospace, transportation, sensing, and biomimetics industries.

In Search of Appropriate Processing and Packaging Protocols for Ghanaian Street Foods: The Case of Molded Corn-Peanut Wrap "Saabo"

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Background

Street foods are part of culinary culture, offering unique experiences deeply rooted in local traditions. Among these, Saabo, a popular Ghanaian street food made of cooked corn and peanut wrapped in corn husks, faces challenges concerning food safety and preservation. This study presents an overview of various protocols designed to aseptically package and preserve Saabo, ensuring its safety and extending shelf-life while maintaining its authenticity over a relatively long time.

Methodology

Various protocols and preservation methods, including treatment with antimicrobial agent to impede microbial growth, and vacuum packaging to provide safe packaging and storage platform were explored. Firstly, the traditional method of Saabo preparation was explored to serve as a control. Briefly, dry corn was steeped for 3 h and then mixed with peanuts. The corn-peanut mixture was assembled into sterilized corn husks, molded into elongated shapes, and threaded with yarn. The wrapped mixture was boiled in water for 2 h, packaged and stored at different conditions. Next, 0.1% and 0.05% w/v potassium sorbate (PS) were added to the corn-peanut mixture prior to molding, cooking, and packaging. Alternatively, the corn was soaked together with 0.3% w/v PS for 3 h before adding the peanut, followed by vacuum packaging and storage either under ambient conditions or refrigeration.

Results

Saabo prepared from the traditional method showed microbial (mould) growth after three days of storage. In the presence of 0.1% and 0.05% w/v PS, there was still mould growth after three days, likely due to sublimation of the PS during cooking, hence reducing its inhibitory effect. Soaking of corn in 0.3% w/v PS prior to boiling and vacuum packaging, however, yielded the desired results. This PS concentration was sufficient to effectively suppress mould growth. The Saabo through this protocol lasted for three weeks on the shelf at room temperature without any sign of mould growth. This was confirmed through microbial and sensory analysis.

Conclusion and Impact

The consumption of street foods is rising, hence the need to aseptically process and package them to extend their shelf-life. In this study, 0.3% w/v PS treatment of corn produced Saabo that is wholesome both at room and cold temperatures. Aside aiding storage, the vacuum package could also provide good aesthetic outlook suitable for potential commercialization of Saabo. The outcome of this research thus lays strong foundation for future studies focused on improving the value-chain of Saabo and other related street foods.

Keywords: Saabo, street food, potassium sorbate, antimicrobial agent, sensory analysis

Optimization of Process Variables to Produce Whole Cashew Kernels Using Response Surface Methodology

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Background

Cashew (Anacardium occidentale) is a vital economic crop on the international market. Thermal processing, specifically drying and steaming is the adopted preservation technology in making this cash crop available all year round. This research involves critical study of the unit operations required in the dehulling or peeling of whole cashew nut and makes attempts to reduce the persistent high breakages encountered through process optimization via response surface methodology, RSM.

Methodology

The steaming time, drying time, drying temperature and shaft speed for peeling are the operational parameters that were studied to determine their effects on the moisture content and breakage of cashew kernels. These factors were optimized to produce whole cashew nut kernels through RSM with five-level-four-factor full factorial central composite design (CCD).

Results

The optimum conditions were found to be 30 mins of steaming, 8 mins of drying time at a drying temperature of 85 ℃ and a shaft speed of 100 rpm. This resulted in moisture content of 4.2 and drastically reduced breakage rate of 3.13, meeting the Association of Food Industries (AFI) standards for cashew nuts.

Conclusion and Impact

This exploratory research aims to help cashew nut processing companies in effectively reducing the high loss of whole kernels encountered during processing for sale. Consequently, it will help to reduce processing cost and conserver resources, thereby maximizing overall operational gain.

***Keywords*:** Response surface methodology, breakage, whole cashew kernels, operation parameters, shaft speed

Pineapple Leaf Fiber Sheets Coated with Carbonated-hydroxyapatite Particles as a Potential Oxygen Remediation Material

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Background

Low blood oxygen levels in the human body result in respiratory disorders and cause improper breathing. Oxygen therapy is a corrective measure used to supply supplementary oxygen to patients suffering from respiratory disorders. Oxygen gas cylinders are widely used in hospitals and health facilities for oxygen therapy. Oxygen delivery systems are designed together with hospitals, which results in expensive oxygen delivery, especially in low- and middle-income countries (LMCs). Oxygen concentrators (OCs) have been proven to be a better substitute for oxygen therapy. OCs use zeolite sieves to filter mainly nitrogen and other gases from atmospheric air for oxygen therapy. However, the zeolite sieves compromise with time, and replacing the sieves is expensive. Thus, the authors use carbonated hydroxyapatite (CHAp) to coat pineapple fiber (PALF) sheets to produce an alternative oxygen filter for oxygen therapy.

Methodology

PALF were chopped into tiny pieces and placed in a rectangular mold with a dimension of cm to form sheets. The sheets were then coated with CHAp using a spray pyrolysis deposition method. X-ray diffractometry (XRD) and Fourier transform infrared spectroscopy (FTIR) were used to characterize the coated PALF sheets. A 3-D-printed cylinder was inserted into the empty cylinders of an OC and stacked with the PALF/CHAp sheets. Oxygen purity was measured for 15 min at a flow rate of 2.0 LMP using an UtraMaxO2 oxygen analyzer.

Results

The XRD patterns of CHAp, PALF sheet, and PALF/CHAp sheet before and after oxygen purity measurement showed the crystallographic planes of hydroxyapatite and calcite, which is indicative of carbonated hydroxyapatite. After oxygen purity measurement, PALF/CHAp showed distinct peaks resembling ammonia and water. The PALF/CHAp sheet recorded 85.60% after oxygen purity measurement, whereas the PALF alone recorded 21.00%.

Conclusion and Impact

PALF/CHAp sheet was created to serve as asorption material to entrap nitrogen gas from atmospheric air. The characterization data of the PALF/CHAp sheet revealed phases and functional groups that corresponded to ammonium bicarbonate and ammonia. The measured oxygen purity was 85.60% higher than the WHO recommended value of 82.00%. The findings raise the prospect of using the PALF/CHAp sheets as a simple and cost-effective oxygen remediation material in clinical oxygen therapy devices.

***Keywords*:** Carbonated Hydroxyapatite, Pineapple fiber, Oxygen, Nitrogen, Oxygen therapy device

Effects of Dough Fermentation on the Microstructure and Rheological Properties of Ga Kenkey, a Fermented Maize Dumpling

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Background

The rheology and textural characteristics of Ga kenkey affect consumer acceptability. This is because fermentation could change the amorphous region of starch granules and textural properties (i.e., hardness and stickiness), leading to modifications in the physical and textural properties of cereal-based products. It also largely influences the viscosity, mouthfeel, and consistency of starch-based products. This research studied the effect of fermentation treatments on the microstructure and rheological properties of Ga kenkey.

Methodology

Corn dough samples were allowed to ferment spontaneously for 0, 24, 48, and 72 h and then used in preparing Ga kenkey samples. The various parameters that were measured include pH, moisture content, water activity, pasting properties, textural profile and microstructure of the corn dough and Ga kenkey samples.

Results

Generally, the pH of Ga kenkey decreased with increasing fermentation time. Water activity (aw) values of all the Ga kenkey samples were higher than 0.98 confirming its high susceptibility to microbial growth and short shelf-life. In terms of the textural properties, 48 h fermented Ga kenkey depicted the highest textural (stickiness, cohesiveness and adhesiveness) profile values compared to 24-h and 72-h fermented Ga kenkey. This may suggest that the 48-h fermentation is sufficient to produce Ga kenkey which is acceptable to consumers that prefer highly sticky, cohesive and adhesive end product. Pasting properties were accessed using Rapid Visco Analyzer (RVA) where the 48-h fermented corn dough had the highest peak viscosity of 367±10.6 cP. Also, the fermentation treatments did not significantly affect the various corn dough samples' pasting temperatures (91.1-93.9 °C). SEM micrographs showed pronounced crystalized structures and thinner walls in the 72-h Ga kenkey compared to the 48-h Ga kenkey. This may be attributed to the recrystallization of the disrupted amorphous starch regions.

Conclusion and Impact

In Ga kenkey, such pronounced crystallized structures are undesired as they could lead to undesired textural properties. Thus, reducing fermentation time from 72 h to 48 h could increase the production rate within a shorter processing period to produce consumer-acceptable Ga kenkey.

***Keywords*:** Ga kenkey, fermentation, microstructure, texture, pasting properties.

Synthesis and Characterization of TiO2 – Plasmonic Thin Films and their Photocatalytic Properties

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Background

The environmentally friendly treatment method of photocatalytic oxidation can completely oxidize organic pollutants into harmless inorganic substances. TiO2 (titanium dioxide) is a common photocatalyst that has the potential to significantly increase the photodegradation efficiency by which pollutants are broken down, but its practical application is plagued by it inactivity in visible light. This problem can be remedied by modifying pure nanostructured TiO2 with plasmonic materials such as silver (Ag).

Methodology

In this research work Sol-gel spin coating method was used in the synthesis of pure and silver modified TiO2 on FTO glass substrate. Silver concentration of 3%, 7% and 10% were used in the modification of TiO2. The effect of silver concentration on optical properties of TiO2 and its photodegradation efficiency were investigated and analysed using UV-vis spectroscopy.

Results

UV-Visible analysis indicated that as the silver content increases, the bandgap decreases from 3.49 eV to 3.12 eV thus shifting it from the ultraviolet to visible region. Alternating layers of pure TiO2 and pure Ag were studied and it was observed that as more layers are being added, the bandgap decreases from 3.71 eV to 2.91 eV. The degradation efficiency of MB after 3 h of UV exposure for pure TiO2, 10% Ag-TiO2, 2 layered film and 5 layered film was 59%, 73%, 24% and 63%, respectively.

Conclusion and Impact

This research findings projects the use of materials modified with TiO2 in the environmental sector, particularly for water and air purification. TiO2 was modified by doping with Ag to significantly increase its photocatalytic performance. The UV-visible spectroscopy confirms that the Ag have a certain influence on the improvement of the photocatalytic activity.

***Keywords*:** Titanium dioxide, sliver, sol-gel spin coating, photocatalysis, thin film

Synthesis of Superhydrophobic Surfaces using TiO2, Halloysite Nanotubes and Low Surface Energy Molecules.

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Background

Superhydrophobicity is an interesting field of research that has recently received attention following its potential applications. The concept is simply the ability of a surface of any tangible material to completely repel water and exhibit a very low level of wettability. Superhydrophobic surfaces are characterized by water contact angle of more 150o, contact angle hysteresis of less than 10o and sliding angle of less than 5o. This concept can be used in self-cleaning surfaces, anti-icing surface, anti-corrosion, oil-water separation and many more. Sol-gel method, chemical vapor deposition, electrospinning are methods previously employed in fabricating such surfaces. This research work used dip and spray coating as an alternative method in synthesizing superhydrophobic surface with TiO2 nanoparticles, Ag and halloysite nanotubes (HNTs).

Methodology

The noble metal, Ag (0.5 wt. % of Ag) was loaded onto TiO2 by the photo deposition method. Nanocomposites of HNT-Ag-TiO2 and HNT-TiO2 made up of different percentages of HNTs were synthesized and spray-coated unto a glass substrate. The above coatings were made superhydrophobic by inclusions of 2.627 mM and 8 mM of myristic and stearic acid, respectively in the synthesis process. The superhydrophobicity on different coatings was characterized by the water contact angle (WCA) of coating on 30 glass substrates containing various mass percentages of HNT, TiO2, and Ag-TiO2.

Results

Coating the glass substrate with HNT-Ag-TiO2 and HNT-TiO2 introduced roughness onto the surface of the glass and this had an impact on the WCA. This was demonstrated as WCA of HNT-Ag-TiO2, with 33.33 wt% HNT after roughening was 64.32°, implying a rise in the WCA from an initial value of 27o. Incorporating low surface energy molecules, myristic acid, and stearic acid influenced the WCA. In general, stearic acid showed promising results as compared to myristic acid. The vast difference in the performance of the two acids resulted from the relatively lower concentration of myristic acid. Superhydrophobic WCA of 160.25° and 152.21° were achieved for HNT-TiO2 with 0 wt% HNT and 33.33 wt% HNT, respectively after adding stearic acid, implying that the surface was completely non-wetting.

Conclusion and Impact

A simple and cost-efficient method for creating glass surfaces that repel liquids was successfully showcased through spray and dip-coating techniques. Different ratios of HNT, TiO2, and Ag-TiO2 nanoparticles were employed to produce surfaces with varying degrees of water repellency, ranging from hydrophobic to superhydrophobic.

Keywords: Superhydrophocity, water contact angle (WCA), Low surface energy molecules, hydrophocity, Photodeposition.

Design of UV-C Disinfection Robots for Hospitals in Ghana

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Background

The COVID-19 pandemic emphasized the critical need for effective and safe disinfection practices in healthcare, especially in regions like Ghana facing resource constraints. Conventional manual disinfection methods have proven insufficient and carry risks for sanitation workers. This project introduces a cost-effective UV-C disinfection robot tailored for deployment in Ghanaian hospitals. The project aims to reduce infection risk, increase safety for patients and healthcare workers, and improve disinfection times.

Methodology

The robot was designed using Fusion 360 and Tinker Cad and programmed using Arduino IDE. A visual representation of the robot's physical appearance including its size, shape, and component placement was created using Fusion 360. Tinker CAD was used to select and interconnect the electronic components, forming a robust electrical system after which Fusion 360 was employed to seamlessly integrate UV-C light and brushes into the robot's design for effective surface disinfection and debris removal. To enhance functionality, an Artificial Potential Field navigation system was incorporated to facilitate precise movement within the hospital environment and target specific disinfection areas. A light detection and ranging (LIDAR) sensor was also incorporated in the design to provide a detailed and accurate mapping of the environment, allowing navigation through stationary and slow-moving obstacles in real time and adjusting its cleaning approach where necessary. Finally, the model was tested in a simulated hospital environment ensuring that it communicated well with the hospital environment.

Results

The UV-C light effectively disinfects surfaces, while the navigation system enables precise targeting, optimizing disinfection times. The robot was highly effective in navigating around stationary and slow-moving obstacles as well as fast moving and unforeseen obstacles. The UV-C disinfection robot showed a low risk of UV-C exposure to health workers due to the robot's quick response to turning off the UV-C upon detecting a fast or unfamiliar object.

Conclusion and Impact

The project aims to significantly enhance disinfection processes in Ghanaian hospitals by reducing infection risk, increasing safety for patients and healthcare workers, and improving disinfection times. This low-cost UV-C disinfection robot has great potential to improve disinfection processes in Ghanaian hospitals by providing a safer, more efficient, and cost-effective solution compared to manual disinfection methods

***Keywords*:** UV-C disinfection, Covid-19, Artificial Potential field, LIDAR, robotic disinfection

Utilization of Banana Stem-Derived Activated Carbon for Atrazine Mitigation

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Abstract

A cost-effective form of activated carbon, known as Banana Stem Activated Carbon (BSAC), was developed to aid environmental conservation through the removal of atrazine pesticide from wastewater. Its production involves a moderate pyrolysis temperature and duration. In the manufacturing process of BSAC, banana stem powder was soaked in a solution of H_3PO_4, which acts as the activating agent. Subsequently, this impregnated stem powder is subjected to pyrolysis at a temperature of 500 °C for one hour. The treatment led to a substantial enhancement in the surface area of the BSAC. The BSAC was characterized using Fourier infrared spectroscopy (FTIR) and Scanning electron microscopy (SEM). In this research, the impact of BSAC dosage, temperature, and initial atrazine solution concentration was examined at different contact durations. The use of BSAC in low doses resulted in high atrazine removal efficiency. The BSAC demonstrated a maximum removal efficiency of 85.36 % and a maximum adsorption capacity of 42.68 mg/g. The equilibrium adsorption isotherm that best fit the study was the Langmuir isotherm model as it shows monolayer adsorption, and the kinetic model that best fit the study was the Pseudo second-order kinetic model. BSAC is an environmentally favorable adsorbent in atrazine removal from aqueous media.

***Keywords*:** Atrazine, Adsorption, Monolayer, Isotherm

Comparative Studies of The Electronic and Optical Properties of Surface Fluorinated Perovskite Layer for Enhanced Solar Cell Performance Using Density Functional Theory (Dft) Approach

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Abstract

Solar energy stands at the forefront of sustainable development goals, aiming to provide affordable and clean energy as part of the 2030 Agenda. Organic-inorganic halide perovskite materials offer immense potential to revolutionize the energy industry and contribute to this goal. These materials surpass the limitations of traditional silicon-based solar cells with their low-cost, high-power conversion efficiency, and compatibility with flexible substrates. This study employs density functional theory (DFT) to investigate the electronic and optical properties and the impact of a fluorinated surface molecule on perovskite solar cell materials (PSCs).

By analyzing the electronic and optical properties, we gained crucial insights into the behavior and performance of these solar cells. We found that the passivated structures exhibited a higher band gap compared to the pure structures. This indicates enhanced stability which is crucial for long-term device performance and reliability in solar cells. The results from density of states (DOS), electronic charge density, orbital analysis and optical properties showed that passivation with SHF improved the stability and performance of the PSCs.

Keywords: Perovskite Solar Cells (PSCs), Passivation, Density Functional theory (DFT),

Device For Detecting and Tracking Labour Conditions for Pre-Term Delivery Using Machine Learning

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Background

Preterm delivery occurs before 37 weeks of gestation and is a significant global health challenge. It is responsible for over 80% of neonatal deaths and can impact a child's physical, mental, and social development. Conventional methods for detecting and monitoring labour conditions include manual uterus palpation and an Intrauterine Pressure Catheter (IUPC) device. However, these methods have limitations such as low sensitivity and specificity, inability to provide real-time data on uterine activity, and invasive procedures fraught with risks. Detecting and monitoring preterm conditions is crucial for deploying rapid intervention measures to preserve human life. This project offers a solution that involves the development of two devices enhanced with machine learning techniques to extract trends and patterns in data to track, detect, and make predictions in a non-invasive manner.

Methodology

The two developed devices were designed for monitoring, detection and prediction tasks: a patient monitoring device and a central controller device. The patient monitoring device has integrated sensors that capture contractions and extract critical parameters (duration, frequency, and intensity) transmitted wirelessly to the controller device. The machine learning algorithm employed in the controller device evaluates the patient's data to predict preterm conditions, classify them, and generate alerts through buzzers and LCDs. The model was developed, trained on a public dataset, and tested on 517 samples. The model achieved 98% accuracy in training and validation.

Results

The detection and monitoring system through experiments using pre-diagnosed patient data from the TPEHG database on Physionet and actual muscle contraction data from volunteers, was tested to detect preterm and non-preterm conditions with 99.7% and 97.5% performance accuracies, respectively. Preliminary findings affirm the device's efficacy, showcasing its ability to accurately and promptly detect and track labour conditions for preterm delivery while ensuring user-friendliness and comfort for pregnant women.

Conclusion and Impact

The devices in their developmental phase, have the potential to significantly improve maternal care by providing early warnings for preterm delivery and mitigating the global challenge of premature births. Its reliability in monitoring preterm delivery conditions and its ability to generate critical condition alerts make it particularly beneficial in resource-limited settings. The devices also enable early interventions by identifying irregular uterine parameters and alleviating routine check-ups through remote recording capabilities. It also serves as a comprehensive data analysis tool, facilitating informed decision-making.

Keywords: Preterm delivery, Machine learning, Uterine contractions, Maternal care, Neonatal health

Developing A Frugal Design for Contactless Product Dispensers

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Background

The COVID-19 pandemic, caused by the novel coronavirus SARSCoV-2, has spread rapidly worldwide, leading to a wide range of symptoms and severities in infected individuals. As much as COVID-19 is no longer a significant threat, it is still important to carry out preventive measures against air-borne infection. It was observed that the distribution of surgical face masks was done manually. This could lead to the spread of disease by contact. Existing dispensers of face masks were either contactless but difficult to acquire or easy to obtain but required contact. A need arose for contactless dispensers that could be easily sourced locally. It was observed that the device could be used for more than face masks if proper adjustments to the system were made.

Methodology

Extensive market research was done to ensure that the design approach adopted produced a dispenser that stands out in terms of both innovation and usability. A brainstorming session was held to generate several concepts to which a decision matrix that assigns weighted scores to each predetermined criterion was applied. The material selection process involved meticulous evaluation criteria aligned with budget constraints and environmental considerations. All materials used were locally sourced. An infrared (IR) sensor, an Arduino Uno microcontroller and an instruction code were featured in the design to coordinate and control the functioning of the mechanical parts of the design. The system's safety measures include a belt drive and dual infrared sensors to ensure single mask dispensing and minimize contact.

Results

A device that uses infrared motion sensors to trigger a delivery system of stored products was produced. The device is made of locally sourced and accessible materials.

Conclusion and Impact

This project encouraged others to create devices from local materials. It also made contactless dispensers more accessible to the Ghanaian community for various uses.

***Keywords*:** COVID-19, product dispenser, infrared (IR) sensor, microcontroller, belt drive

Development of Electron Density Phantom for Computed Tomography Image Quality Control Procedures

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Background

Quality control (QC) is vital in diagnostic radiology departments, particularly in computed tomography (CT), to enhance image quality and minimize radiation exposure to patients and staff. However, the unavailability of electron density phantoms (EDP) in Ghana hampers these critical quality control procedures. Therefore, there is an urgent need to develop a local electron density phantom to improve imaging quality and optimize radiation dose management.

Methodology

The proposed study will involve meticulous formulation of tissue mimicking materials using oven-dried and finely powdered coconut components with additives to closely relate human tissue density and determine their Hounsfield Unit (HU) values through CT scans. Following this, the development of local electron density phantom simulating both the head and body. The phantom design will be created with Autodesk AutoCAD software, emulating the CIRS model, featuring 33cm diameter for the body and head, including water-filling holes. Seventeen cavities will be incorporated and distributed across the head and body sections, and a 3D printer with PLA filament will be used for manufacturing. The performance validation will entail conducting Philips Ingenuity Core CT scans on the phantom, which contains test tubes of low X-ray attenuation filled with the tissue mimicking materials, using 120 kV settings to generate Hounsfield unit data for electron density measurement calibration, with subsequent comparison to a commercial electron density phantom.

Results

Successful characterization of human tissues, development and validation of an affordable, locally produced electron density phantom for diagnostic radiology departments in Ghana. This innovative phantom is anticipated to significantly enhance image quality in CT scans and contribute to more effective radiation dose management. The comparison of the developed EDP phantom with a commercial electron density will likely demonstrate the viability of this locally developed solution to improve patient and staff safety while maintaining high-quality diagnostic imaging.

Conclusion and Impact

The development of a locally produced electron density phantom using 3D printing with PLA filament and coconut-based tissue-mimicking materials is expected to address the critical need for quality control in diagnostic-radiology department in Ghana, improving image quality and radiation dose management. This innovative solution is poised to enhance patient and staff safety and maintain high-quality diagnostic imaging, as it will be evidenced by the comparison of a commercial electron density phantom.

***Keywords*:** electron density phantom, characterization, tissue mimicking materials, Computed tomography, 3D printing.

Home Energy Management, Monitoring And Control System

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Background

The increasing global demand for energy, alongside the inefficiencies in energy consumption, has driven electricity utilities to generate more power to meet user needs, leading to cost implications for both the utility and users. To manage energy usage of users, electricity utilities deploy diverse techniques such as time-of-use, load shedding, among others. Since residential users constitute a significant proportion of the overall energy consumption, implementing energy management schemes that could help the residential users to directly manage their energy usage could help the users manage their energy budget and also help the utility in managing their generation. This research addresses the challenges by introducing a home energy management and control system. Comprising a smart socket and a central controller, this system gives residential users the platform to manage their energy consumption, reducing energy costs.

Methodology

The home energy management and control system consists of two main components: a smart socket and a central controller system. The smart socket includes sensors to measure voltage and current from connected appliances, which it uses to compute power and energy requirements. This data is wirelessly transmitted to the central controller for processing and optimization. The central controller, equipped with operational logic, regulates appliance scheduling and control. It communicates decisions to the smart socket for implementation through its integrated relays. The system also features a web application for monitoring, tariff settings, appliance scheduling, and manual control.

Results

The developed prototype home energy management system was tested in an experiment to validate its operational performance. The results reveal that the system is able to effectively monitor, control, schedule, and manage connected appliances, resulting in reduced energy usage and cost savings. Test results show that the system was able to save cost of energy usage through the optimization strategies. In the experiment, appliances (water heater, phone and laptop) were scheduled and operated for 2 hours with ratings of 1500W, 15W, and 45W respectively. The smart socket adequately captured their power and energy consumption, correctly communicating the operational costs to the user.

Conclusion and Impact

The system enables users to remotely monitor, control and schedule appliances to minimize costs Moreover, the solution will help the utilities by enabling users to manually schedule appliances to run during off-peak periods.

***Keywords*:** Home energy management, smart socket, controller system, raspberry pi, microcontroller.

Electrochemical Performance of Ripe Plantain Peels Activated Carbon for Supercapacitor Electrode Application

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Abstract

The world's increasing need for energy highlights the importance of finding clean, economical, and efficient ways to store it. In addressing these pressing challenges, this study explores the potential of ripe plantain peel activated carbon (RPPAC) for supercapacitor electrode application. Ripe plantain peel powder (RPPP) was activated via a chemical activation method using phosphoric acid as the activating agent. The activated powder was sieved into 75µm and 125µm particle sizes. The activation process transformed the morphology of RPPP into a porous structure in RPPAC, creating more ion diffusion sites. The RPPAC was characterized using Scanning Electron Microscopy (SEM), X-ray Fluorescence (XRF) and Fourier Transform Infrared Spectroscopy (FTIR). An electrode was created by mixing RPPAC into a slurry and spreading it on a nickel foam current collector. Cyclic Voltammetry (CV) and galvanostatic charge-discharge tests were conducted using a 3M KOH electrolyte solution. The 75µm RPPAC showed superior capacitive performance over the 125µm RPPAC, with specific capacitance values of 10.51nF/g at 10mV/s scan rate and 0.87nF/g at 100mV/s scan rate. This research reveals the potential of RPPAC in supercapacitor electrode application, which contributes to advancing sustainable and economical energy storage solutions.

***Keywords*:** Supercapacitor, Activated carbon, Slurry

A Pilot Testing of a Biochar Filter for improving surface water quality for irrigation

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Abstract

Due to water scarcity, the use of water from streams and drains for irrigating crops has become necessary to reduce the demand on treated water for irrigation. In this study, the performance of a biochar filter as an efficient low-cost surface water treatment option for irrigation was investigated. Water from a local stream (Onyasia) was passed through two sets of filters (roughing and fine filters) with sizes (4 mm-8 mm and 1 mm-4 mm) ranges respectively.

Physio-chemical and biological pollutants of the influent and effluent were tested. The average flow rate of the filters was about 12-15 L/h (220 ml/min – 250 ml/min), with a theoretical retention time of 7.5 hours. The filter operated at a temperature range of 20 to 31°C for 9 weeks (63 days). Data that was collected during the course of the experiment indicates a great performance of the filter. The system recorded an average removal efficiency of 88% for turbidity, 86% for *Clostridium perfringens*, 80% for *E. coli*, 80% for total coliform, 55% for TSS, 25% for COD and 1.5% for TDS.

The effluent concentration of both biological and physicochemical parameters was within the acceptable range recommended by the FAO (1992) and WHO. However, some of them exceed and this was attributed to operational factors such as unstable flowrate which was a major limitation in this study. The results obtained implies that biochar filter system is efficient in removing most of the parameters (biological and physicochemical) that affects crops during irrigation and impose health problems to humans when these crops are consumed. This innovation would lead growing pathogen-free crops which would cause no health threat to its consumers.

Keywords: Water scarcity, Surface water, Water treatment,Biochar, Irrigation, Onyasia stream.

Spray Drying of Coconut and Tiger Nut Milk Powder: A Comparative Study of Response Surface Methodology (RSM) and Machine Learning Models

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Abstract

Process optimization is an essential activity for many industries in the world today. In the food processing industry, optimization plays a major role in planning and production so as to increase yield while cutting down on industrial waste and cost. Dehydration as a food preservation technique is used to reduce moisture content in food products which leads to the reduction in microbial activities. Spray drying is an efficient drying method which converts feed from a fluid state to a dried particulate form by spraying the feed into a hot drying chamber.

In this study, the response surface methodology and machine learning regression models (Decision Tree and Random Forest) were developed to forecast the effect of input parameters on spray drying of coconut and tiger nut milk (CTM). The experimental design utilized the central composite design and generated a dataset of 20 runs. Input parameters for spray drying, specifically intake temperature (160-180°C), feed flowrate (350-450 ml/h), and maltodextrin concentration (5.5-10%) were varied. The moisture content and the yield of the composite milk powder were found to be significantly ($p < 0.05$) affected by maltodextrin ratio and drying inlet air temperature. Results indicated that optimal conditions were obtained at an inlet temperature of 180°C, a 10% maltodextrin concentration, and a 4500 mL/L feed flowrate with predicted response of 4.2% moisture content, wettability in 17.02s and 50.1% yield. Different regression models, including Linear Regression, Random Forests (RF), and Decision Tree (DT), were employed to predict output responses using the given input parameters. During the validation process, the decision tree model demonstrated the highest performance, achieving an R^2 value of 0.94 and a Root Mean Square Error (RMSE) of 1.50, 0.011, 1.40 and 0.00 for yield, moisture content, color change and wettability respectively. Comparatively, Random Forests yielded slightly improved results compared to linear regression, but the interpretability of Random Forests was more straightforward. Notably, both machine learning models showed significantly superior accuracy compared to linear regression. Furthermore, the decision tree regression model was implemented as a web application, allowing users to calculate spray drying output parameters based on their input values.

***Keywords*:** Plant-based milk powder, Food preservation, Optimization, Machine learning

Design and Implementation of Lorawan-Based Monitoring Systems for Smart City

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Abstract

The need for sustainable smart city solutions is driven by rapid urbanization and environmental concerns. Smart cities use advanced technology to improve living standards and resource efficiency across various sectors like transport, environment, energy, education, healthcare and governance. LoRaWAN technology connects sensors in urban areas effectively and affordably. While many smart city initiatives use LoRaWAN for applications like smart parking and environmental monitoring, they face issues like scalability, tracking and high deployment costs. This project addresses these challenges with four key low-cost monitoring systems: Air Quality, Environmental, Water Level and Inflow/Outflow and Smart Streetlights, contributing to a more livable and sustainable urban environment.

Existing monitoring systems lack scalability, wide coverage and real-time monitoring capabilities to respond quickly to environmental hazards and energy efficiency issues, leading to increased utility cost, diseases and even death. In this project, we designed and developed LoRaWAN-based Air Quality, Environmental, Water Level and Inflow/Outflow Monitoring and Smart Streetlight systems to reliably collect data. We also implement a central network server for data aggregation and analysis, and finally, data collected is made available to stakeholders and city planners for urban sustainability and improved living standards.

The project involves the design and deployment of sensor nodes equipped with appropriate sensors for each monitoring system. LoRaWAN gateways are strategically placed to ensure adequate coverage. Data collected by the sensor nodes are transmitted to a central network server using LoRaWAN communication. The server processes and stores the data for real-time monitoring and historical analysis. Finally, processed data is made available to stakeholders and city planners through user-friendly interface.

This project confirms LoRaWAN-based monitoring systems efficiently gather and transmit data with low energy use. They offer real-time insights on air quality, environment, water levels and streetlights, proving the feasibility of LoRaWAN in smart city solutions.

Implementing these monitoring systems in smart cities improves urban planning and resource management. Continuous monitoring of air quality and environmental factors allows proactive pollution control. Water level and streetlight monitoring systems promote sustainability, reducing costs.

Keywords: Smart City, LoRaWAN, Sustainability, Technology, Scalability.

Preparation of Uniform Size and Shape $Pt_3Ni@TiO_2$ Core-Shell Electrocatalyst NPs for Stable PEM-Fuel Cell for Sustainable Renewable Energy.

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Abstract

A strong alternative sustainable source of energy is PEM-FCs, which are being developed mainly for automobiles, stationary fuel cell generators, and portable fuel cell applications. Pt nanoparticles (NPs) are the best material for the electrocatalyst component in these FCs. However, it has challenges with stability/durability and high cost, among others. One approach to overcoming these challenges is to replace part of the Pt with other metals in the form of alloys, which also enhance their performance. $Pt_3Ni(111)$, whose surface is 10-fold more active for the oxygen reduction reaction than the corresponding pristine Pt(111), is such an alloy. However, it de-alloys under FC operation.

In this work we attempted to shell the Pt3Ni in a thin (~ 1-2 nm) TiO2 metal oxide layer in a Pt3Ni@TiO2 core-shell (C-S) morphology to stop the de-alloying as metal oxides have excellent chemical and electrical stability. $Pt_3Ni@TiO_2$ C-S NPs were synthesized using facile techniques of microemulsion/sol-gel and hot-water treatment crystallization to obtain uniformly sized and shaped $Pt_3Ni@TiO_2$ NPs. As controls, pristine Pt_3Ni and TiO_2 NPs were also prepared. The XRD-Scherrer equation results showed $Pt_3Ni@TiO_2$ NPs of about 4 nm with no TiO2 peaks, but the SEM-EDX results showed the presence of TiO_2, suggesting a very thin TiO_2 shell below the detection limit of powder XRD and the desired optimal electrocatalyst NP size of 1.5 nm being achieved. In addition, no secondary phase colors were observed in the $Pt_3Ni@TiO_2$ suspension. These preliminary results suggest a successful preparation of $Pt_3Ni@TiO_2$ C-S NPs.

These findings demonstrate a high potential for making a significant contribution by developing affordable and stable PEM-FCs for home generators, electric vehicles, and electronic devices.

***Keywords*:** $Pt_3Ni@TiO_2$ nanoparticles, Core-Shell, Electrocatalyst, PEM-FCs, and Fuel cell stability

Optimizing a Nutritious, Low-Carbon Diet for Adult Males and Females Using Locally Available Food Ingredients in Ghana

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Abstract

Diet optimization has traditionally focused on balancing nutrition and cost. However, rising concerns regarding the impact of food production on the environment have necessitated the inclusion of environmental considerations in addressing dietary issues. This study was thus conducted to utilize linear programming to propose nutritionally adequate and culturally acceptable food options with minimal greenhouse gas emissions (GHGE) for adult males and females.

To achieve this, linear programming was used to select a list of food items from a set of ninety eight locally available items that met energy, macro, and micronutrient-defined requirements and had minimum GHGE values. Nutrient requirements from the Institute of Medicines for adult males and females were included as constraints, and additional criteria were imposed on the contribution of the food groups to ensure that they were culturally acceptable.

The food basket defined for adult males had a GHGE value of 0.85 g CO2eq./day, and that of adult women had a value of 0.72 g CO2eq./day. Both groups had 16 and 15 food items in their respective food baskets, including three common ingredients in almost all Ghanaian diets. All nutrient requirements were satisfied with no deviations. The dietary trend observed is a shift towards more plant-based foods, legumes, seeds, and nuts, contribution from staples, and complementary protein-sourced foods with no red meat.

Results obtained can be adopted for adult male and female nutrition programs and possibly incorporated into the Ghana food-based dietary guideline.

***Keywords*:** greenhouse gas emissions, sustainability, adequate nutrition, linear programming.

Developing A Predictive Model for Spatiotemporal Gait Parameters of Healthy Young Ghanaian Adults

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Background

This study presents a refined approach to gait analysis and clinical decision-making by addressing the lack of normative spatiotemporal gait data for young Ghanaian adults.

Methodology

The study's focus encompasses individuals aged 18 to 24 years. Utilizing Magneto Inertial Measurement Units (MIMUs), data were collected as participants performed walking trials on a designated path. The collected data underwent rigorous processing, including normalization and filtering to ensure accuracy.

Results

Results from the descriptive statistics showed the average stride length of males and females to be 1.68m $\pm$0.18 and 1.50m $\pm$0.22 respectively; the average stride width of males and females to be 0.07m $\pm$0.02 and 0.06m $\pm$0.02 respectively; and the average stride time of males and females to be 1.39s $\pm$0.12 and 1.34s $\pm$0.16 respectively. Summary output for the simple linear regression using age as the predictor and the spatiotemporal gait parameters as dependent variables showed significant relation to all spatiotemporal parameters except single support time and velocity.

Conclusion and Impact

An Excel-based graphical user interface (GUI) was designed to facilitate real-time prediction of spatiotemporal gait parameters, taking into consideration age, gender, and height. Through the development of a predictive model based on a newly established normative database, conventional reliance on foreign normative databases can be circumvented.

Keywords: gait analysis, spatiotemporal gait data, MIMUs, normalization, predictive model

Halloysite Nanotube as a Vehicle for Chemical Dispersant Application

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Background

A crude oil spill is characterized as a specific incident whereby oil is released over a brief period due to carelessness, accidents, or deliberate action [1]. Oil spills, which typically happen in maritime regions, impact the economy. When the maritime environment is endangered, it harms many different aspects of society, including economies, health, and nutrition. A major limitation that can be encountered upon the application of the chemical dispersant formulated especially as an oil spill response 6 option method is the solubility of the surfactants in water, which allows for a large amount of the chemical dispersant to fade and disappear. The use of environmentally friendly materials as surfactant-carrier greatly reduces the toxicity of oil spill dispersants. In this work, we report Halloysite clay nanotubes (HNTs) loaded with different surfactants for crude oil spill remediation.

Methodology

Halloysite nanotube was loaded with surfactants and the characterized using TGA and FTIR. The effectiveness of HNT loaded with the surfactants protein extract from chicken feather, Tween 80, dioctyl sodium sulfosuccinate salt (DOSS), and soybean lecithin in crude oil spill remediation was examined with the U.S. EPA's baffled flask test. The emulsifying ability was studied and their droplet sizes evaluated.

Results

The surfactant-loaded HNT was characterized using TGA and FT-IR. This was done to determine whether or not the surfactant loaded. 41.71% dispersions effectiveness was attained by HNT loaded with binary blend of protein extract from chicken feather and Tween 80. This blend also generated the most stable emulsions and smallest droplet sizes.

Conclusion and Impact

Thus, an environmentally friendly chemical dispersant was formulated using naturally occurring HNT with food grade surfactant (lecithin), petroleum-based surfactants (DOSS and Tween 80) and protein extract from chicken feather.

***Keywords*:** Halloysite nanotube, protein extract from chicken feather, chemical dispersant, crude oil, surfactant

Design of a Multi-layered Antibacterial Dressing for Effective Unidirectional Exudate Absorption

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Background

The global prevalence of diabetes mellitus (DM) constitutes a pressing public health concern, with projections anticipating 700 million affected individuals by 2045. Diabetes mellitus is closely associated with various complications, one of which is diabetic foot ulcers (DFUs). Wound dressings play a pivotal role in managing DFUs by promoting proper healing and averting further complications. Unfortunately, there are significant shortcomings in the ability of existing wound dressings to treat DFUs. These limitations include suboptimal design, low shock protection, inadequate absorbency, pain during removal, risk of maceration, and the need for frequent dressing changes. These factors collectively contribute to inadequate wound management and hinder the proper healing of DFUs.

Methodology

The study involved a methodical engineering design process guided by well-defined objectives and specifications. The specifications were used to generate multiple concepts that sought to address the current limitations of wound dressings for DFU management. Additionally, a rational selection process was used to identify suitable materials for an ideal wound dressing. The selection of these materials was guided by a comprehensive decision-making tool, considering their individual properties, thus ensuring a harmonious blend that effectively addresses the multifaceted challenges associated with DFU management. Computer simulation using SolidWorks and COMSOL Multiphysics played a pivotal role in validating the proposed design. These assessments encompassed absorption tests, quantifying exudate absorption capacity; pressure flow tests, evaluating structural integrity under pressure; bacteria diffusion tests, assessing the dressing's ability to prevent bacterial infiltration; and moisture vapour transmission tests, measuring moisture regulation capabilities.

Results

The design process led to the development of a five-layered wound dressing composed of silver nanocrystalline sheets, honey-infused hydrogels, chitosan, sodium polyacetate, and a polyurethane film. In testing, this innovative dressing demonstrated notable characteristics, including efficient exudate management, satisfying mechanical strength (18 MPa), and elongation at break (40 ± 2%), and meeting moisture regulation standards (WVTR of 1900 ± 30 g/m²/day). Furthermore, the dressing is anticipated to possess long-term antimicrobial properties and absorption capacity.

Conclusion and Impact:

In summary, the study presents a promising five-layered wound dressing for DFU treatment. It is essential to highlight that while computer simulations provide valuable insights, they do not account for real-time clinical factors. As a result, it is imperative to move forward with the development of an actual prototype. Real-world testing of this prototype is essential to validate all results and ensure that the dressing meets the expected specifications.

Keywords: Diabetic Foot Ulcers, Wound Dressing, Material Selection, Simulation Testing, Antibacterial Properties

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