23rd International Symposium on Advanced Technology

Engineering Innovations for Net Zero: Advancing Low Carbon Strategies

ISAT-23

BOOK OF ABSTRACTS

CONFERENCE OVERVIEW

In the midst of the global call for climate change and environmental degradation awareness, the field of engineering plays a crucial role in exploring, developing, and implementing sustainable strategies and technologies to address this need.

Bringing together experts, researchers, and industry leaders from the different parts of the world to act on the urgent challenges of climate change, through engineering innovations and sustainable practices in operations, is a relevant step towards achieving net zero carbon emissions and low carbon footprints. By integrating advanced technologies and innovations in building a robust and environmentally responsible world, providing a sustainable future to the next generation to come is secured.

Herewith, the 23rd International Symposium on Advanced Technology (ISAT-23) aims to initiate the advancement of cutting-edge engineering innovations that are crucial in achieving net zero carbon emissions through research presentations. The symposium aims to promote and introduce emerging technologies, sustainable infrastructure, industrial systems and processes, as well as policy and implementation strategies. This will involve a series of activities including plenary and parallel sessions to present and discuss innovations and strategies as well as networking sessions to foster collaboration and partnerships.

This initiative, organized by the University of the Philippines System through the UPLB College of Engineering and Agro-industrial Technology, intends to share knowledge and advance understanding, encourage collaboration, and showcase actionable insights for policy creation and drive implementation of low-carbon strategies across universities and institutions as well as in our respective countries.

ABOUT ISAT

The International Symposium on Advanced Technology (ISAT) is an annual event organized and spearheaded by the Engineering Departments of Kogakuin University (KU) of Japan since 2002 for future cooperation between universities. ISAT focuses on joint research in the applied sciences devoted to resolving pressing national and social issues. Other consortium universities include The University of Danang- University of Science and Technology (DUT) in Vietnam, Southern Taiwan University of Science and Technology (STUST) in Taiwan, and the University of the Philippines (UP). The UP System was officially recognized as a member of the consortium through the UPLB College of Engineering and Agro-industrial Technology in 2017 and was renewed in 2024.

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MESSAGE FROM THE UPLB CHANCELLOR

On behalf of the University of the Philippines Los Baños (UPLB), I extend my warmest congratulations to all the organizers and participants of the *23rd International Symposium on Advanced Technology (ISAT-23).* This year's theme, "Engineering Innovations for Net Zero: Advancing Low Carbon Strategies," underscores the pivotal role that engineering plays in addressing one of the most critical issues of our time – achieving net zero carbon emissions.

ISAT-23 provided a vital platform for experts, scholars, and innovators from around the world to share their research and developments in engineering technologies that contribute to sustainable environmental practices. Your collective efforts and discussions at this symposium are crucial for pioneering low-carbon strategies that will not only mitigate the impacts of climate change but also drive us towards a more sustainable and resilient global community.

UPLB, through its College of Engineering and Agro-Industrial Technology, is proud to be part with an event that not only promotes scientific excellence but also fosters collaboration that transcend geographical and disciplinary boundaries for the sake our planet's future.

May this symposium inspire all attendees to continue pushing the boundaries of what is possible in engineering and technology. The research presented and ideas shared here are essential for building a sustainable world for current and future generations.

GENERAL PROGRAMME

DAY 1 ACTIVITIES
21 November 2024

TOUR	
TIME (PH)	**VENUE**
14:30- 15:30	Center for Agri-Fisheries and Biosystems Mechanization (BIOMECH)
15:30- 16:30	Agricultural Machinery Testing and Evaluation Center (AMTEC)
16:30- 17:30	Agrometeorology, Bio-Structures and Environment Engineering Division, Institute of Agricultural and Biosystems Engineering (ABSEED-IABE)
17:30 – 19:30	WELCOME DINNER
WELCOME DINNER PROGRAM	
17:30 - 18:00	Registration
18:00 - 18:05	*Welcome Remarks:* **PROF. REX B. DEMAFELIS** *Dean and Professor* *College of Engineering and Agro-industrial Technology* *University of the Philippines Los Baños*
18:05 - 18:10	*Message:* **PROF. JOSE V. CAMACHO JR.** *Chancellor* *University of the Philippines Los Baños*
18:10 - 18:15	UPLB Talent Pool Performance 1
18:15 - 18:20	UPLB Talent Pool Performance 2
18:20 - 19:30	SOCIAL NIGHT AND DINNER

DAY 2 PROGRAM OF ACTIVITIES
22 November 2024

UMALI AUDITORIUM, SEARCA, UP LOS BAÑOS

	OPENING CEREMONY
07:45 – 08:25	Registration and Presentation of ISAT-23 Consortium
08:25 - 08:35 *Welcome Message*	**PROF. JOSE V. CAMACHO, JR.** *Chancellor* *University of the Philippines Los Baños*
	KEYNOTE SPEECHES
08:35 - 08:55	**PROF. REX B. DEMAFELIS** *Dean & Professor* *College of Engineering and Agro-industrial Technology* *University of the Philippines Los Baños*
08:55 - 09:15	**PROF. MOTOYASU KOBAYASHI** *Professor* *Department of Applied Chemistry* *School of Advanced Engineering, Kogakuin University*
09:15 - 09:35	**PROF. WEI-CHIN CHANG** *Director of General Affairs & Professor* *Department of Mechanical Engineering* *Southern Taiwan University of Science and Technology*
09:25 – 09:45	**DR. PHAN NHU THUC** *Senior lecturer* *Faculty of Environmental Engineering, University of Science and Technology* *The University of Da Nang, Viet Nam*
09:45 - 10:00	**MORNING TEA**
10:00 – 16:20	**PARALLEL SESSIONS & POSTER PRESENTATIONS**
16:20 – 17:20	**BREAK**
17:20 – 17:50	**AWARDING CEREMONY**
17:50 – 18:00 *Closing Remarks*	**ASST. PROF. BERNADETTE T. MAGADIA** *Associate Dean* *College of Engineering and Agro-industrial Technology* *University of the Philippines Los Baños*
18:00 – 19:00	**DINNER**

ASST. PROF. CHRISTIAN LAURENCE E. AQUINO
Master of Ceremonies

TECHNICAL PRESENTATIONS

CHEMICAL AND ENVIRONMENTAL ENGINEERING, CLIMATE CHANGE, FLUID MECHANICS, AND WASTE MANAGEMENT	
PARALLEL SESSION (UMALI AUDITORIUM)	**Session chair: RAMON CHRISTIAN P. EUSEBIO** **Co-chairs: JOHN FREDERICK D. TAPIA** **BERNADETH T. MAGADIA**
10:00 - 10:10 (ONLINE)	**ISAT23.0104 (VIDEO)** | **Franchesca Maye Rubang** | *Reduction of Scrap in Battery Manufacturing using Lean Six Sigma*
10:10 - 10:20 (ONLINE)	**ISAT23.0048 (VIDEO)** | **Daiki Iwaya** | *Coanda Effect of Underwater Synthetic Jet*
10:20 - 10:30 (ONLINE)	**ISAT23.0043 (VIDEO)** | **Jaco Fritz Rosellon** | *Model-Based Analysis of Breakthrough Curves for the Extraction of Plant Growth Regulators from Wastewater*
10:30 - 10:40 (ONLINE)	**ISAT23.0107 (VIDEO)** | **Neil Rose Tajan** | *Parametric Study on Rice Straw-Based Membrane Fabrication using DMSO-Acetone Solvent*
10:40 – 10:50 (ONLINE)	**ISAT23.0105 (VIDEO)** | **Polo Jerome Daquipil** | *Parametric Study on Membrane Fabrication with Sugarcane Bagasse and DMSO/Acetone*
10:50 – 11:00	**QUESTION & ANSWER**
11:00 - 11:10 (ONLINE)	**ISAT23.0098 (VIDEO)** | **Phuong Doan** | *Biogeochemical Functioning of Turbid Tropical Reservoirs: The Case Study of Cointzio, Mexico*
11:10 - 11:20 (ONLINE)	**ISAT23.0077 (VIDEO)** | **Zennia Marie Granado** | *Storage Effects on the Extraction of Plant Growth Regulators from Waste Coconut Water*
11:20 – 11:30 (ONLINE)	**ISAT23.0078 (VIDEO)** | **Arianne Mer Paas** | *Development of Colorimetric Indicator Starch-Gelatin Films Incorporated with Butterfly Pea Flower Anthocyanins*
11:30 – 11:40 (ONLINE)	**ISAT23.0074 (VIDEO)** | **Keiichiro Suzuki** | *Consideration on Stiffness Characteristics of Plane Jet*
11:40 – 11:50 (ONLINE)	**ISAT23.0062 (VIDEO)** | **Phuong Doan** | *Phosporus Retention and Internal Loading in the Bay of Quinte, Lake Ontario, using Diagenetic Modelling*
11:50 – 12:00	**QUESTION & ANSWER**
12:00 – 13:00	**LUNCH BREAK**

CHEMICAL AND ENVIRONMENTAL ENGINEERING, CLIMATE CHANGE, FLUID MECHANICS, AND WASTE MANAGEMENT	
Continued... **PARALLEL SESSION (UMALI AUDITORIUM)**	**Session chair: RAMON CHRISTIAN P. EUSEBIO** **Co-chairs: JOHN FREDERICK D. TAPIA** **BERNADETH T. MAGADIA**
13:00 - 13:10	**ISAT23.0106** | **Lemuel Agonoy** | *Lead Adsorption Assessment Using 3D-printed Coal Fly Ash Zeolite Permeable Reactive Barrier*
13:10 - 13:20	**ISAT23.0088** | **Gerald Aguilar** | *Polyhydroxyalkanoate production by lake bacteria isolated from the sediments of Laguna de Bay, Philippines*
13:20 - 13:30	**ISAT23.0102** | **Kaiser Bardelosa** | *Lead Removal Assessment in Landfill Leachate using Zeolitic 3D-printed Permeable Reactive Barriers*
13:30 - 13:40	**ISAT23.0020** | **Yuna Kobori** | *Separation of HFC-32 from HFC-134a using dimethoxydiphenylsilane-derived silica membranes prepared via CVD*
13:40 - 13:50	**ISAT23.0076** | **Alexander Sydney De Leon** | *Parametric Study on the Bioextraction of Polyhydroxybutyrate (PHB) Biodegradable Plastic from Simulated Biomass using Black Soldier Fly Larvae*
13:50 – 14:00	**QUESTION & ANSWER**
14:00 - 14:10	**ISAT23.0091** | **Gewelle Mae Punzalan** | *Coconut Water as a Carbon Source for Sustainable Polyhydroxyalkanoate (PHA) Bioplastic Production by Cupriavidus necator KCTC 2649*
14:10 - 14:20	**ISAT23.0093** | **Carlito Reyes** | *Investigating Ultrasound as Means for Improving Transesterification Reactions for Microalgal Biodiesel: A Case Study*
14:20 - 14:30	**ISAT23.0015** | **Tomohide Takami** | *Growth of soft crystals of phthalocyanine-derivatives at 1-phenyloctane/graphite interface*
14:30 - 14:40	**ISAT23.0090** | **Jaren Tulipan** | *Enhanced Poly(3-hydroxybutyrate) Bioplastic Production in Cupriavidus necator KCTC 2649 via Fed-batch Culture with Glucose as Substrate*
14:40 - 14:50	**ISAT23.0080** | **John Rafael Unlayao** | *Valorization of Eucheuma denticulatum hydrolysate as a Potential Substrate for Polyhydroxyalkanoate (PHA) Bioplastic Fermentation*
14:50 – 15:00	**QUESTION & ANSWER**
15:00 – 15:10	**BREAK**

CHEMICAL AND ENVIRONMENTAL ENGINEERING, CLIMATE CHANGE, FLUID MECHANICS, AND WASTE MANAGEMENT	
Continued... **PARALLEL SESSION (UMALI AUDITORIUM)**	**Session chair: RAMON CHRISTIAN P. EUSEBIO** **Co-chairs: JOHN FREDERICK D. TAPIA** **BERNADETH T. MAGADIA**
15:10 - 15:20	**ISAT23.0087** | **Butch Bataller** | *Evaluation of Cadmium Removal from Landfill Leachate using Zeolitic Permeable Reactive Barriers (PRB)*
15:20 - 15:30	**ISAT23.0041** | **Kanon Orihara** | *Influence of Frequency of Adjacent Synthetic Jet on Behavior of Pulsating Jet*
15:30 - 15:40	**ISAT23.0042** | **Masahiro Takano** | *Unsteady Flow Characteristics of Two Plane Synthetic Jets under Interference*
15:40 - 15:50	**ISAT23.0060** | **Kohei Okuma** | *Deflection Characteristics of Main Jet by Circular Cylinder with Double Jet Sheets*
15:50 - 16:00	**ISAT23.0049** | **Kaito Suzuki** | *Restoration Process of Plane Jets to Flow Disturbances*
16:00 - 16:10	**ISAT23.0101** | **Rederick Justin Lara** | *Layout Optimization for Efficient Materials Recovery Facility (MRF): A Systems Simulation-Based Approach*
16:10 – 16:20	**QUESTION & ANSWER**
End of Parallel Session for Chemical and Environmental Engineering, Climate Change, Fluid Mechanics, and Waste Management	

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ISAT-23

Oral Presentation *Chemical And Environmental Engineering, Climate Change; Fluid Mechanics; Waste Management*

Reduction of Scrap in Battery Manufacturing using Lean Six Sigma

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ABSTRACT

The Dry Charge Department Plate Section of an integrated battery manufacturer in the Philippines was experiencing a constantly high scrap rate, which has a monthly average of 76,348 kilograms, costing them Php 7,634,800 every month. This is about 82% higher than their expected monthly plate scrap of just 42,000 kilograms for the year. Plates are scrapped due to mistrim, misaligned pasting paper, incomplete paste, plate deformation, and stickiness of plates. Ishikawa diagram and root cause analysis were used to determine the root causes and the different factors that contribute to the occurrence of the problem. The unnecessary scraps were determined to be instigated by man, machine, measurement, materials, and management factors. To verify the identified root causes, further discussion was done with the workers who have the best knowledge on the production of dry charged plates. To categorize the factors to be identified, a CNX analysis was also performed. It was found that the lack of Pokayoke processes, the absence of Andon signals, and the obsolescence of equipment all directly contribute to the high scrap rate. Development and implementation of standardized processes specific for scrap reduction in the planning, production, and post-production was considered. Upon providing alternatives and implementing solution such as mechanical cutter replacement, the scrap level in the continuous pasting line of the Dry Charge Department was reduced by 34.40% from 2.79% to the current 1.83%. Moreover, the target 4-sigma level was achieved, leading to a 2,210 decrease in the defects per million opportunities in the negative excel plate production. The average cost incurred by the negative excel plate also decreased from Php 940,551 to the current Php 398,471.70, showing a 57.63% cost reduction. Due to the limited time of the study, other identified controllable and experimental factors were not implemented and elaborated on in this study. The researcher recommends further observation of these factors after implementation to determine their significance and contribution to the reduction of scrap on the line.

KEYWORDS

scrap reduction, lean six sigma, battery manufacturing, root cause analysis, CNX analysis

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Engineering Innovations for Net Zero: Advancing Low Carbon Strategies
ISAT-23

Oral Presentation *Chemical And Environmental Engineering, Climate Change; Fluid Mechanics; Waste Management*

Coanda Effect of Underwater Synthetic Jet

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ABSTRACT

Research on excited jets, in which vectoring of the jet can be achieved without changing the geometry, has attracted much attention. Synthetic jets are jets generated by oscillatory flow with separation at the outlet slot, and it is known that the net flow rate is zero at the slot, but a jet structure with real flow rate is formed downstream. That is, there is no need for a fluid supply upstream of the outlet slot, and in principle the flow can be generated by an oscillating body even inside a closed container. Another important feature of synthetic jets is that they are inherently unsteady flows and therefore have parameters related to time. These findings suggest that the flow inside a closed container can be generated by an oscillating body and controlled by time parameters such as the oscillation frequency. However, there have been few studies on synthetic jets in water, and it is no exaggeration to say that synthetic jets in liquid containers are largely unexplored.

This study attempted to elucidate the behavior of planar synthetic jets in a two-dimensional rectangular tank. The experimental study focused mainly on the relationship between the coanda effect of the synthetic jet and the free surface. To visualize and observe the flow in the tank, water was mixed with ion exchange resin particles of approximately 90 μm in diameter as tracers, and the behavior of the particles was tracked by a high-speed camera and PIV processing was performed. The main results were that when a free surface exists near the synthetic jet generated in a two-dimensional rectangular tank, the jet is attracted to the free surface due to the coanda effect, and that the vortex region formed in the tank depends on the offset ratio determined by the slot width and the distance between the slot and the free surface. The vortex region formed in the tank depends on the offset ratio determined by the slot width and the slot-to-free-surface distance.

KEYWORDS

Underwater Synthetic Jet, Coanda Effect, Tank, Free Surface

23rd International Symposium on Advanced Technology
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Oral Presentation *Chemical And Environmental Engineering, Climate Change; Fluid Mechanics; Waste Management*

Model-Based Analysis of Breakthrough Curves for the Extraction of Plant Growth Regulators from Wastewater

Jaco Fritz L. Rosellon[1, a *], Mart Merwin C. Magboo[1, b], Monet Concepcion N. Detras[1, c], Catalino G. Alfafara[1, d] Butch G. Bataller[1, e]
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ABSTRACT

The extraction of valuable compounds from liquid waste streams is crucial for sustainable resource management and pollution prevention. However, traditional extraction methods often suffer from low efficiency and high costs. This study aimed to develop a model-based approach to optimize the extraction process using a specific adsorbent. By analyzing breakthrough curves, the researcher investigated the relationship between linear velocity, relative adsorption capacity (RAC), and length of unused bed (LUB). The findings revealed an optimal linear velocity within the tested range (0.2-1.2 cm/min) that maximizes RAC and minimizes LUB. The Thomas model was selected as the best model for predicting breakthrough curves due to its interpretable parameters and good statistical fit (adj R^2 > 0.885). Sensitivity analysis of the Thomas model revealed that linear velocity, bed height, and bed porosity influence key parameters such as breakthrough time, RAC, LUB, and theoretical pressure drop. To optimize linear velocity, two approaches were employed: a surrogate model-based optimization approach and an experimental data-based optimization approach. Both methods converged on an optimal linear velocity of 0.93 cm/min that maximized RAC and minimized LUB. Validation experiments confirmed this optimum value, further demonstrating the Thomas model's ability to predict breakthrough curves. A framework for translating experimental batch adsorption data to estimated column parameters was proposed. This framework enables researchers to leverage batch adsorption data to estimate Thomas model parameters and allow simulations to predict the breakthrough curve, streamlining future research and reducing the time and resources spent on extensive column experiments. This study demonstrates the potential of model-based approaches for improving the process of extracting valuable compounds from liquid waste streams. Future research should focus on storage effects and alternative adsorbents to enhance sustainability and economic viability.

KEYWORDS

Breakthrough curve modeling, wastewater treatment, process improvement, extraction optimization

23rd International Symposium on Advanced Technology
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Oral Presentation *Chemical And Environmental Engineering, Climate Change; Fluid Mechanics; Waste Management*

Parametric Study on Rice Straw-Based Membrane Fabrication using DMSO-Acetone Solvent

Neil Rose M. Tajan[1,a *], Michael Vincent O. Laurio[1,b], Mart Merwin C. Magboo[1,c], Butch G. Bataller[1,d], Ramon Christian P. Eusebio[1,e]
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ABSTRACT

This study explored the potential of using a dimethyl sulfoxide (DMSO)-acetone solvent system to fabricate rice straw-based cellulose acetate (RS CA) membrane. Approximately 80% of rice straw (RS) is disposed of through open field burning, which poses health and environmental risks. Due to the high cellulose content of rice straw (RS), it became a potential source of cellulose acetate (CA). The RS cellulose was extracted by dilute alkali treatment and bleaching using 1 wt.% and 6 wt.% NaOH, and 0.25 wt. % NaOH and 10 wt.% H_2O_2, respectively. This process resulted in a yield of 0.3 g RS cellulose per g of RS, and a purity of 82.34%. The RS cellulose was then acetylated using acetic acid, acetic anhydride, and sulfuric acid, producing a yield of 1.45 g RS CA per g of RS cellulose, and a DS value of 3.05. The RS CA membrane was fabricated using non-solvent induced phase separation (NIPS) with DMSO-acetone as the solvent system. A 2^k factorial experiment was conducted to determine the significance of factors such as RS CA mass percentage, DMSO-acetone ratio, membrane thickness, and their interactions on water permeability and salt rejection. For water permeability, all main factors and their interactions had p-values of less than 0.05, indicating statistical significance. The interaction between RS CA mass percentage and the DMSO-acetone ratio showed the greatest significance. For salt rejection, RS CA mass percentage and the interactions between RS CA mass percentage with the DMSO-acetone ratio, and the DMSO-acetone ratio with membrane thickness, had p-values greater than 0.05, showing its statistical insignificance. Despite the general trade-off observed between water permeability and salt rejection, the RS CA membrane fabricated under conditions of 14% RS CA, a 1:1 DMSO-acetone ratio, and a 250 µm membrane thickness performed well on both responses, resulted in a water permeability of 101.15 $L/m^2 \cdot h \cdot bar$ and a salt rejection rate of 53.58%.

KEYWORDS

Rice straw, cellulose acetate, membrane fabrication, DMSO-acetone

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Oral Presentation *Chemical And Environmental Engineering, Climate Change; Fluid Mechanics; Waste Management*

Parametric Study on Membrane Fabrication with Sugarcane Bagasse and DMSO/Acetone

Polo Jerome G. Daquipil[1,a *], Michael Vincent O. Laurio[1,b], Mart Merwin C. Magboo[1,c], Butch G. Bataller[1,d], Ramon Christian P. Eusebio[1,e]
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ABSTRACT

This study investigated the fabrication of cellulose triacetate (CTA) membranes sourced from sugarcane bagasse (SCB) and using dimethyl sulfoxide (DMSO) and acetone as solvents for greener membrane fabrication. SCB is a cellulose-rich byproduct from sugarcane milling. While half of SCB is used as fuel for mill boilers, some are disposed of as waste. Rather than waste, SCB can be valorized into higher-value products such as CTA for membrane production. High-purity SCB cellulose was extracted from raw SCB using solutions of 5 wt% NaOH, 0.5 wt% EDTA, and 2 wt% alkaline H_2O_2. SCB cellulose was then acetylated to SCB CTA using acetic acid, acetic anhydride, and sulfuric acid as a catalyst, obtaining an average degree of substitution value of 2.86. FTIR spectroscopy was used to compare the functional groups of materials after chemical treatments. SCB CTA membranes were created using non-solvent induced phase separation, cold gelation bath and gradual annealing bath while varying solvent-cosolvent ratio and evaporation time. 2^k factorial design of experiments were used to determine the effects of the varied membrane fabrication factors, solvent ratio, and evaporation time, on porosity, permeability flux, salt rejection and sugar rejection. Factorial experiment results showed that the main factors were significant ($p<0.05$) to all responses aside from sugar rejection, while interaction effects between the factors were only significant for salt rejection and porosity. Experiments on sugar rejection were also performed, however no membrane presented rejection. Furthermore, scanning electron microscopy (SEM) was used to observe the surface structure of the CTA membranes produced. Mean pore size was computed using Guerout-Elford-Ferry equation and it was determined that CTA membranes produced were applicable within ultrafiltration-microfiltration range.

KEYWORDS

Membrane fabrication, cellulose acetate, sugarcane bagasse, green engineering

Oral Presentation *Chemical And Environmental Engineering, Climate Change; Fluid Mechanics; Waste Management*

Biogeochemical Functioning Of Turbid Tropical Reservoirs: The Case Study Of Cointzio, Mexico

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ABSTRACT

The Cointzio reservoir in Mexico (capacity 66 Mm3) is characterized by a lack of water treatment plants upstream and a high content of very fine clay particles. It suffers serious episodes of eutrophication associated with high levels of turbidity and benthic anoxia. In this study, a numerical simulation of physical and biogeochemical processes was applied for this very turbid and highly eutrophic tropical reservoir. Different scenarios for future climate inputs, nutrient inputs and water levels were simulated. The results pointed out that an increase of average air temperature coupled with a low water level could lead to critical conditions with a severe depletion of dissolved oxygen and important chlorophyll a (up to 94 µg L−1). The calculations indicated that a drastic reduction of nutrient inputs (up to 90%) would be required to significantly reduce chlorophyll a concentrations. If such mitigation measures are adopted, the maximum peak of chlorophyll a would be reduced by 55% after a ten-year period of efforts, with corresponding positive effect on dissolved oxygen concentrations.

KEYWORDS

AQUASIM, tropical reservoir, eutrophication, turbid, Mexico

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Oral Presentation *Chemical And Environmental Engineering, Climate Change; Fluid Mechanics; Waste Management*

Storage Effects on the Extraction of Plant Growth Regulators from Waste Coconut Water

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ABSTRACT

The extraction of valuable phytohormones from waste coconut water (WCW) poses challenges due to varying storage conditions. This research investigated how storage temperature, container type, and duration impact phytohormone adsorption using granular activated carbon (GAC) as the adsorbent. The results of the study revealed that over time, especially at room temperature, turbidity increased due to microbial growth and enzymatic browning, pH decreased due to organic acid production by lactic acid bacteria, and Brix decreased as sugars were consumed by microbes. Conductivity increased at room temperature but decreased at freezing temperature due to electrolyte crystallization. Adsorption efficiency positively correlated with pH and Brix while negatively correlated with conductivity and turbidity. Freezing temperature in a closed container for five hours was identified as the best storage conditions, yielding the highest adsorption efficiency. Batch adsorption experiments using WCW stored under these conditions determined the equilibration time and effective adsorbent loading of GAC to be 60 minutes and 200 g/L, respectively. The adsorption process followed the Freundlich isotherm and exhibited a better fit to the pseudo-second order kinetic model. Thin layer chromatography and densitometric analysis estimated the volumetric extraction yield (VEY) of phytohormones under the best storage conditions as 322.4 µg/L for kinetin, 93.35 µg/L for IAA, 892.1 µg/L for GA3, and 211.6 µg/L for IBA. These values were higher than the VEY obtained under room temperature storage, despite having similar theoretical initial concentrations. While storage conditions do not directly degrade phytohormones in WCW, they significantly influence the adsorption process, thereby affecting the VEY of phytohormones. Recommendations include exploring pH buffering methods for WCW stored at room temperature to maintain high adsorption efficiency. Adjusting the pH to favorable levels may promote better interactions between phytohormones and GAC, potentially mitigating the negative effects of microbial activity and enzymatic reactions. This approach could offer a more practical and energy-efficient alternative to freezing, particularly for large-scale operations.

KEYWORDS

Phytohormones, adsorption, granular activated carbon, waste coconut water, volumetric extraction yield

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Development of Colorimetric Indicator Starch-Gelatin Films Incorporated with Butterfly Pea Flower Anthocyanins

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ABSTRACT

Challenges in food preservation and quality monitoring have driven the need for intelligent packaging, as traditional methods relying on expiration dates often fail to account for external factors during storage and transportation. This can result in consumers either unknowingly consuming items that have spoiled, raising safety concerns, or discarding food that remains safe to eat, contributing to unnecessary waste. In response to growing concerns on food safety and sustainability, this study developed colorimetric indicator films by incorporating butterfly pea flower anthocyanins (BPFA) into starch/gelatin composites as pH-responsive indicators for monitoring food freshness. BPFA extraction was performed via ultrasonication, yielding a total monomeric anthocyanin content (TMAC) of 135.33 ± 2.29 mg/L. The extract exhibited color changes across a pH range of 1 to 12, demonstrating strong pH-responsive behavior. Effects of varying anthocyanin loading (0.34 mg, 0.68 mg, 1.01 mg) and drying temperatures (60°C, 70°C, 80°C) on the films' color, tensile strength, water vapor permeability (WVP), and pH-responsiveness were investigated. Higher anthocyanin content improved color intensity and reduced WVP, but weakened the tensile strength due to interactions between BPFA and the polymer matrix. Stability tests conducted over 20 days at 28°C in dark conditions revealed minimal discoloration, suggesting that the films maintain stability under these conditions. This study highlights the potential of BPFA-loaded films to provide real-time indicators of food freshness, however, optimizing the mechanical properties is essential to ensure durability throughout a product's shelf life. Recommendations include exploring the use of fresh butterfly pea flowers for anthocyanin extraction, adjusting the starch-gelatin ratio in film-forming solutions, and incorporating filler materials to enhance film properties. Additionally, investigating other anthocyanin sources or combinations may broaden the films' pH response range, particularly within the pH 4.0 to 8.0 range, which is critical for detecting food spoilage.

KEYWORDS

anthocyanins, intelligent packaging, butterfly pea flower, starch-gelatin films, food freshness monitoring

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Consideration on Stiffness Characteristics of Plane Jet

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ABSTRACT

Water jet processing is one of the methods that utilize the rigidity of water jets, which are generated by injecting pressurized liquid through a nozzle. Generally, it is explained that material failure occurs when the “cessation pressure” of the jet exceeds the strength of the material. By the way, the recent pandemic of the new coronavirus has brought attention to the use of air curtains (plane jets) for the purpose of preventing droplet infection. The logic is that the rigidity of plane jets, i.e., their space-separating effect, can be used as a substitute for rigid walls to suppress the diffusion of aerosol particles. However, there have not been many systematic investigations focusing on the stiffness of water jet processing and air curtains, even though their functions are closely related to the stiffness of the jet, and no unified view has been obtained on the evaluation method.

In this study, the stiffness of plane jets is considered. The response characteristics of the jet are mainly investigated numerically by applying a disturbance to a well-developed, plane-steady, continuous jet. The disturbances were time-varying geometrical boundary conditions and velocity changes due to vortex-pair collisions. The numerical simulation code used was scFLOW by Hexagon, with a mesh size of about 200000 and a standard k-ε model as the turbulence model. The main results of the simulation are that the velocity field and vorticity distribution of the plane jet are calculated, that the behavior of the plane jet after being disturbed depends on the type of disturbance, and that the time required from the measurement of the velocity change at the reference point to the return of the plane jet flow field to the condition before the disturbance impact depends on the action time of the disturbance.

KEYWORDS

Plane Jet, Disturbance, Stiffness, CFD, Velocity Flactuation

Oral Presentation *Chemical And Environmental Engineering, Climate Change; Fluid Mechanics; Waste Management*

Phosphorus Retention and Internal Loading in the Bay Of Quinte, Lake Ontario, using Diagenetic Modelling

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ABSTRACT

In this study, we investigated phosphorus (P) cycling in the Bay of Quinte, an embayment of Lake Ontario, Canada. Despite a decline of external P loading to the Bay during last decades, it still experiences harmful cyanobacterial algal blooms, which were hypothesized to be connected to nutrient loading from sediments. However, dynamics of nutrient loading from sediments remain largely unknown. Our modelling framework integrated physical and biogeochemical processes at the sediment-water interface (SWI) and incorporated dynamic boundary conditions, such as oxygen, soluble reactive phosphorus concentrations and organic matter sedimentation at the SWI.

The results indicate spatial and temporal differences in P retention across the three basins of the Bay, depending on sedimentation history, the form of P, topography, and previous land use characteristics. The model results show that recently, accumulated P has decreased at two shallow sites (B and N), which may increase the amount of P released from the sediments. In contrast, at the deeper site HB, P accumulation remains high and stable, corresponding to lower and almost unchanged P release. Our scenarios suggested that P release and retention can profoundly respond to shifts in sedimentation conditions. At all three studied stations, P release and retention did not change significantly after the scenario year 2034 when we reduced 20% flux of organic matter. Especially, it had a large reduction of P release at the station B in 2034 after reducing 20% P flux comparing to the present condition. However, for the station HB, the reduction of 20% flux of organic matter may not large enough to be able to reduce P release remarkably.

KEYWORDS

AQUASIM, sediment modeling, eutrophication, Bay of Quinte

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Lead Adsorption Assessment Using 3D-printed Coal Fly Ash Zeolite Permeable Reactive Barrier

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ABSTRACT

Coal combustion products from thermal power plants cause significant environmental problems. Even though coal fly ash (CFA) is generally considered a waste product of coal combustion, it has a wide range of uses in construction and chemical production. One of its potential applications is in the production of zeolitic materials. These materials are greatly considered for their application in heavy metal removal from wastewater. This study aimed to study the removal mechanism of the zeolites synthesized from coal fly ash in the adsorption of lead from a synthetic landfill leachate. Zeolite materials of Na-type and sodalite were analyzed by X-ray diffraction (XRD) to be present in the synthesized product. The adsorption data were analyzed using the Langmuir and Freundlich isotherm model. With the estimated correlation coefficient, it was found that the adsorption data are more accurately explained by the Langmuir isotherm and the pseudo-second-order kinetic model. These models suggest that the synthesized zeolite has the potential to be used as an alternative source in the production of heavy metal adsorbents. By using the synthesized zeolite, a permeable reactive barrier (PRB) was 3D-printed using the Eazao Bio 3D printer using a nozzle diameter of 1.2 mm, printing speed of 5 mm/s, and extrusion pressure of 0.3 MPa. By soaking one PRB in the same synthetic landfill leachate solution, it was found that the removal capacity of one PRB is approximately 18%. This means that it would take about six PRBs to completely remove the lead initially present in the solution.

KEYWORDS

Adsorption, Zeolite, Permeable Reactive Barrier, Coal Fly Ash, 3D-Printing

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Polyhydroxyalkanoate production by lake bacteria isolated from the sediments of Laguna de Bay, Philippines

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ABSTRACT

The use of petroleum-based plastics has become a staple in the daily lives of people around the world. Plastics can be used in various applications such as in healthcare, packaging, textile, automotive, and construction. However, these plastics take millions of years to be degraded in the environment, and a large portion of them end up in landfills or floating in marine waters which endangers all forms of life, most especially humans. To mitigate this problem, polyhydroxyalkanoates (PHAs), biopolymers produced by a wide array of microorganisms, are seen to be excellent alternatives for petroleum-based plastics. In the present study, isolated PHA-producing bacterial strains from Laguna de Bay, Philippines were screened using Sudan Black B staining and confirmed using PHA detection agar (PDA) with Nile Blue A stain. Out of 28 bacterial isolates, 16 strains were identified as PHA producers. Three isolates, namely TDS05, TDS23, and MLS36, were randomly selected for phenotypic characterization and PHA fermentation. Results showed that TDS05 had a wide range of carbon utilization and exhibited lipolytic activity, suggesting that the strain is a good candidate for PHA fermentation. Isolate TDS05 was able to produce PHA using glucose as the carbon source in the growth medium, producing 1.98 g/L of PHA within 48 hours which is comparable with other wild-type PHB-producing bacteria isolated from the environment. These findings suggest that TDS05 has huge potential for industrial-scale PHA production.

KEYWORDS

polyhydroxyalkanoate, bioplastic, bacteria, Laguna de bay

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Oral Presentation *Chemical And Environmental Engineering, Climate Change; Fluid Mechanics; Waste Management*

Lead Removal Assessment in Landfill Leachate using Zeolitic 3D-printed Permeable Reactive Barriers

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ABSTRACT

Permeable reactive barriers have emerged as an effective passive remediation technology for contaminant plumes, utilizing sustainable materials like recycled waste, byproducts, or non-manufactured materials. Zeolites, known for their excellent adsorption properties, are hydrated crystalline aluminosilicates with alkali or alkaline earth metals, characterized by a highly ordered microporous structure. This study investigates a 3D-printed PRB incorporating NaCl-pretreated natural zeolite for lead removal from synthetic sanitary landfill leachate. Ansys Fluent simulations were conducted to assess flow dynamics within a leachate pipe containing the PRBs. The results showed a maximum interstitial velocity of 1.58×10^{-3} m/s within the porous media, indicating turbulence, efficient fluid distribution, and a significant pressure drop, all of which optimize interaction between fluid and reactive material, enhancing adsorption and ion exchange. The PRB, designed with a square-pitched configuration and printed using a Tronxy Moore 2 Pro 3D printer, was integrated into a piping system to treat synthetic leachate containing lead. An optimal 30:50 solid-to-liquid ratio and 80:20 zeolite-to-binder ratio were determined for printability. FTIR analysis revealed aluminosilicate groups, essential for adsorption, dominated the PRB composition. Experimental results showed a maximum lead removal efficiency of 81.76% within 5 minutes, with triplicate runs maintaining consistent removal rates of 70-80%. Batch adsorption tests demonstrated near-complete removal within 1 minute and 99.75% within 15 minutes, due to lead's small hydrated radius and low enthalpy of hydration. Further recommendations should explore alternative binders, curing techniques, and desorption methods to enhance PRB reusability and longevity.

KEYWORDS

lead removal, permeable reactive barrier, zeolite, 3D-printing, numerical modeling

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Oral Presentation *Chemical And Environmental Engineering, Climate Change; Fluid Mechanics; Waste Management*

Separation of HFC-32 from HFC-134a using dimethoxydiphenylsilane-derived silica membranes prepared via CVD

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ABSTRACT

Hydrofluorocarbons (HFC), used as refrigerant gases in place of chlorofluorocarbons (CFC) and hydrochlorofluorocarbons (HCFC), have zero ozone depletion potential. However, their global warming potential is several thousand times larger than that of CO_2. Therefore, demand for HFC-32, which has a relatively low global warming potential of 625, is increasing. A method for separating and reusing HFC-32 from the mixed refrigerant gases used in the past is required. Distillation is the conventional separation method, though it is difficult since these refrigerant gases are azeotropic mixtures. Considering the separation mechanism, we believe membrane techniques would achieve an excellent separation with lower energy. In this study, the separation of HFC-32 from HFC-134a was conducted with dimethoxydiphenylsilane (DMDPS)-derived amorphous silica membranes. DMDPS-derived amorphous silica membranes were fabricated via the counter-diffusion chemical vapor deposition at 600 ℃ after twice γ-alumina coating on α-alumina substrates (OD:12 mm, pore size: 0.121 μm) followed by the calcination at 600 ℃. The permeances of H_2, N_2, SF_6, HFC-32, and HFC-134a were measured (H_2, N_2, SF_6: 25~300 ℃, HFC-32, HFC-134a: 25~200 ℃). Furthermore, the permeances of HFC-32 and HFC-134a in binary mixtures were evaluated by changing the composition. The permeance of HFC-32 was on 10^{-9} mol m^{-2} s^{-1} Pa^{-1}, while that of HFC-134a was on 10^{-11} mol m^{-2} s^{-1} Pa^{-1} within the temperature we tested. The order in the permeances was in accordance with the sizes of the gases. Moreover, the ideal selectivity of HFC-32/HFC-134a was 95.0, 81.4, and 31.6 at 200 ℃, 100 ℃, and 25 ℃, respectively, which were more than 10 times higher than the polymer membranes, such as polyetherimide membranes. In conclusion, we demonstrated that the separation of HFC-32 from HFC-134a using DMDPS-derived amorphous silica membranes prepared via CVD was feasible.

KEYWORDS

Silica membrane, Dimethoxydiphenylsilane, CVD, Gas separation, Refrigerant gas,

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Parametric Study on the Bioextraction of Polyhydroxybutyrate (PHB) Biodegradable Plastic from Simulated Biomass using Black Soldier Fly Larvae

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ABSTRACT

Polyhydroxyalkanoates (PHA) such as polyhydroxybutyrate (PHB) are polymeric compounds that are fully biodegradable, non-toxic, and have modifiable mechanical and physical properties. PHAs are good candidate for replacing traditional plastics and other bio-based polymers such as polylactic acid (PLA) which can persist in marine environments for decades or centuries. However, conventional methods for extracting PHAs from the producing cells utilize toxic solvents such as chloroform which can negatively affect the environment. Due to this, scientists in recent years have been exploring the use of biological agents to extract PHA such as insect larvae to develop a greener PHA extraction method called bioextraction. Black soldier fly larvae (BSFL) have garnered attention due to their short life cycle and ability to accumulate nutrients from food waste making it useful to serve as animal feed in their pupal stage. In this bioextraction study using BSFL, the larvae are given food waste at its early stages of development, and then fed with simulated biomass of known amounts of PHB (Biomer™, Germany, 98.8% purity) entrapped in alginate, for two days near the end of its larval stage. BSFL then consumed the simulated biomass and excreted PHB molecules along with the frass. The resulting fecal matter was then purified and analyzed for its bioextraction efficiency and PHA content. This study aims to identify the effects of feeding factors such as feed loading (%/48hrs), starvation time (hr), and additional feeding time (hr) on the yield of the extracted PHA and the efficiency of the bioextraction process. Experimental results have shown that manipulating the feeding factors can achieve PHA content as high as 93.75% (w/w) but with bioextraction efficiency of 42.52%. At higher bioextraction efficiency of 60.78%, a PHA content of 80.50% (w/w) was achieved. These results indicate that the highest PHA content can be obtained at the lowest bioextraction efficiency and vice versa. The study recommends optimizing the process to achieve an optimal balance between PHA content and bioextraction efficiency.

KEYWORDS

Polyhydroxyalkanoates, biodegradable plastic extraction, bioextraction

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Coconut Water as a Carbon Source for Sustainable Polyhydroxyalkanoate (PHA) Bioplastic Production by *Cupriavidus necator* KCTC 2649

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ABSTRACT

Polyhydroxyalkanoate (PHA) is a class of biodegradable plastic produced by bacteria under nutrient-deficient conditions. Coconut water is widely produced and consumed in the Philippines. Despite its demand, significant amounts of coconut water are still being discarded due to its limited shelf life. Coconut water is composed of various carbohydrates such as glucose, fructose, and sucrose. This study evaluated coconut water as a suitable carbon substrate for *Cupriavidus necator* KCTC 2649 and explored the most effective sterilization technique to ensure microbial growth and PHA accumulation. The coconut water used had a total reducing sugar concentration of 18 g/L. Batch fermentations were conducted using differently prepared coconut water, including fresh, autoclaved, filtered, and synthetic. Between the two sterilization techniques, filtered coconut water yielded the best results, achieving peak biomass of 4.980 g/L at 48 h and PHA concentration of 3.756 g/L (0.417 g/L/h) at 9 h. In comparison, the highest PHA yields from fresh and synthetic coconut water were 54.21% and 2.62% lower, respectively, than those obtained with filtered coconut water.The results show that coconut water is a viable substrate for microbial growth and PHA production, and filtration is the most effective sterilization method for this application.

KEYWORDS

Polyhydroxyalkanoate, Coconut Water, Sterilization Technique

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Investigating Ultrasound as Means for Improving Transesterification Reactions for Microalgal Biodiesel: A Case Study

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ABSTRACT

As fossil fuels deplete and contribute significantly to greenhouse gas emissions, biodiesel from microalgal lipids emerges as a promising green alternative. Microalgae's potential as a space-efficient biodiesel feedstock in the Philippines can be further enhanced by utilizing ultrasound in the transesterification process, potentially advancing the biodiesel industry and promoting sustainable fuel alternatives. This case study compares the effectiveness of ultrasound-assisted transesterification for microalgal lipid conversion to biodiesel with conventional methods. The research examines reaction conditions such as time, temperature, alcohol-to-oil ratio, and catalyst amount, biodiesel yield, and compares results with conventional and microwave-assisted transesterification. Findings indicate that ultrasound-assisted transesterification reduces reaction time, temperature requirements, alcohol-to-oil ratio, and catalyst amount while significantly increasing biodiesel yield compared to conventional methods. It generally outperforms microwave-assisted transesterification in terms of yield, though both yield more biodiesel than the conventional methods. The study demonstrates that ultrasound-assisted transesterification can substantially enhance microalgal biodiesel production, offering a more efficient and environmentally friendly approach to renewable energy generation. Recommendations for future research include exploring the use of ethanol as a reagent, investigating wet in situ transesterification, combining ultrasound and microwave irradiation, studying the effects of varying ultrasound power and frequency, and developing reactor designs for industrial-scale production.

KEYWORDS

Biodiesel, microalgae, transesterification, ultrasound, microwave

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Growth of soft crystals of phthalocyanine-derivatives at 1-phenyloctane/graphite interface

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ABSTRACT

Surface structures of complex organic molecules on solid surface have been investigated for more than a century. Scanning tunneling microscopy (STM) revealed various kinds of surface structure, even at the solid-liquid interface. The growing interest in organic films stems largely from the premise that optical and electronic properties can be systematically controlled and functionalized through molecular design and arrangement. Properties such as dipole orientation and charge injection depend on film structure and orientation with respect to the substrate. Controlled assembly of molecular components on surfaces is a crucial step in the development of many molecular-scale devices. Various efforts in synthesis and self-assembly strategies have resulted in increasingly sophisticated supramolecular structures. Such structures result from the balance between surface-adsorbate, adsorbate-solvent, surface-solvent, and adsorbate-adsorbate interaction. In this paper, we have shown the multilayer phthalocyanine-derivatives, such as octakis(octyloxy)phthalocyanine (OcOPc), Cu-hexadecafluorophthalocyanine (CuHDFPc), formed at the 1-phenyloctane/graphite interface observed by STM. The nuclei growth of phthalocyanine-derivatives was observed by STM at the low currents less than 0.1 nA. In case of OcOPc, STM images show two-dimensional island structure, and rod-like structure along graphite step. The rod-like crystalline structure, indicating the texture structure growth, was also observed with scanning electron microscopy (SEM). The structures observed with STM and SEM were confirmed by transmission electron microscopy (TEM). The X-ray diffraction (XRD) pattern showed two peaks assigned to the c-axis stacking distance of the phthalocyanine cores within the columns, and a broad peak assigned to the long aliphatic chains randomly arranged in the columnar mesophase. On the other hand, in case of CuHDFPc, mainly the rod-like crystalline structure, indicating the texture structure growth, was also observed with STM. The difference in crystal growth mode between OcOPc and CuHDFPc is attributed to the functional group surrounding phthalocyanine; octyl hydrocarbon chains contact with graphite substrate well, whereas fluorocarbon group interacts to graphite substrate so repulsive that π-π interaction between phthalocyanine governs the texture crystal growth, resulting in the formation of rod-like structure.

KEYWORDS

Phthalocyanine, Scanning tunneling microscopy, Graphite, 1-phenyloctane, Soft crystals

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Oral Presentation *Chemical And Environmental Engineering, Climate Change; Fluid Mechanics; Waste Management*

Enhanced Poly(3-hydroxybutyrate) Bioplastic Production in *Cupriavidus necator* KCTC 2649 via Fed-batch Culture with Glucose as Substrate

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ABSTRACT

Plastic pollution is a critical environmental issue, and bioplastics such as polyhydroxyalkanoates (PHAs) offer a promising solution. PHAs are biodegradable, renewable, and biocompatible polymers with properties similar to synthetic plastics, including hydrophobicity and high melting points. Among the most commonly produced PHAs are poly(3-hydroxybutyrate) (PHB). *Cupriavidus necator*, a bacterium known to be one of the most efficient PHA producers, can be used to produce PHB using glucose as a carbon source. *C. necator* synthesizes PHAs under stressful conditions where there is an excess of carbon sources but limited nutrients such as nitrogen. While batch fermentation is the simplest method, it often results in minimal PHA yield. To increase the PHA production, fed-batch fermentation strategy can be done. This involves cultivating bacteria in a nutrient-rich medium initially and then triggering PHA production by feeding a medium with excess carbon and a limited amount of a specific nutrient. In this experiment, we explored the fed-batch fermentation strategy to produce PHB using *C. necator* KCTC 2649. The initial glucose concentration was set at 20 g/L and feeding was initiated when the glucose concentration fell below 20 g/L. The feed was composed of glucose, nutrient solution, trace element solution, and distilled water. Through this fermentation strategy, we achieved biomass concentration of 6.034 g/L containing 88 %w/w PHB (5.311 g PHB/L) with productivity of 0.11 g/L/h. Compared to the batch fermentation strategy, the fed-batch approach increased PHB titer by 208% and PHB productivity by 54%, demonstrating its potential to enhance PHB production efficiency.

KEYWORDS

Bioplastic production, Fed-batch fermentation, Polyhydroxybutyrate, Biopolymer

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Valorization of *Eucheuma denticulatum* hydrolysate as a Potential Substrate for Polyhydroxyalkanoate (PHA) Bioplastic Fermentation

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ABSTRACT

Polyhydroxyalkanoate (PHA) production by fermentation has long been hindered by its high cost, particularly the cost of the substrate needed for microbial growth. Renewable sources such as macroalgae contain sugar utilizable by different microorganisms and can be used as substrate with appropriate pretreatment. *Eucheuma denticulatum,* an underutilized red macroalgae abundant in the Philippines, was investigated for the potential of its hydrolysate as a substrate for PHA fermentation. Sugar-rich hydrolysates were produced by dilute acid hydrolysis in autoclave at 121°C and their total reducing sugar (TRS) concentrations were determined. Three factors were considered for the hydrolysis namely, biomass loading, sulfuric acid concentration, and incubation time. The optimal conditions were identified as 20% biomass loading, 0.15 N sulfuric acid concentration, and 30 minutes incubation time, yielding a maximum TRS concentration of 44.6 g/L, enough for the growth of common PHA-producing bacteria such as *Cupriavidus necator*. However, potential fermentation inhibitors may have also been produced during hydrolysis given the sluggish growth of *C. necator* in medium with *E. denticulatum* hydrolysate as substrate. Thus, a post-treatment processes of the hydrolysates by overliming or activated carbon treatment were explored to reduce fermentation-inhibiting compounds and potentially improve the fermentation process.

KEYWORDS

Hydrolysate, seaweed, biosugar, fermentable substrate, acid hydrolysis

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Evaluation of Cadmium Removal From Landfill Leachate using Zeolitic Permeable Reactive Barriers (PRB)

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ABSTRACT

Permeable reactive barrier (PRB) is a widely used in situ treatment technology that is strategically constructed to intercept a polluted plume by establishing a flow through a reactive material. Zeolites, renowned for their remarkable heavy metal adsorption, have been employed in recent advancements in solid structures for adsorption reactions showing great promise in enhancing wastewater treatment methods, particularly for highly polluted matrices like landfill leachate containing contaminants like cadmium. This study aimed to investigate the potential of natural zeolites as adsorbents incorporated into 3D-printed monolithic structures as PRBs for cadmium removal from synthetic sanitary landfill leachate through flow adsorption. ANSYS simulations were initially done in order to assess the flow characteristics of a PRB-embedded landfill leachate pipe, investigating square- and triangular-grid designed PRBs. Results indicate a steady state flow is achieved with a significant pressure drop in both designs indicating satisfactory collision between particles and adsorbent material. Turbulent flows were also achieved upon entering the pores of the PRB increasing dispersion and the chances of adsorption and ion exchange with the PRB. Consequently, these designs were 3D-printed using a Tronxy Moore 2 Pro 3D printer, with a 1.2 mm nozzle diameter. These PRBs were then installed in a pipe followed by adsorption runs wherein sample concentrations were measured at time intervals ranging from 0.5 to 20 minutes. It was observed that the square- and triangular-grid PRBs were able to achieve maximum cadmium removal efficiencies of 5.91% and 23% respectively after 10 minutes. Beyond this duration, their removal efficiencies gradually decreased indicating saturation and deactivation of adsorption active sites. Batch tests employing pretreated zeolite were also performed in both cadmium standard and cadmium sulfate solutions showing that effective removal was achieved in less than one minute for the former, while it took an hour for the latter containing interfering ions. Further recommendations to the study included exploring pre-treatment methods for natural zeolite to increase its adsorption capacity, calcination techniques to free more active sites in the structure, and desorption techniques to assess the reusability and longevity of the PRB structure over repeated use.

KEYWORDS

cadmium removal, permeable reactive barrier, zeolite, 3D-printing, numerical modelling

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Influence of Frequency of Adjacent Synthetic Jet on Behavior of Pulsating Jet

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ABSTRACT

Personal air conditioning not only reduces energy consumption, but also provides individualized comfort for the user. Jet flow control is a key technology for further popularization in the future. Various functions are required to be added to a single personal air outlet. Typical functions include jet direction control, directivity control, recirculation area control, and unsteady (mixing) characteristic control. Since it is difficult to achieve both simultaneously with a normal steady continuous jet, synthetic jet, which control the direction of the jet, are increasingly being applied. Recently, as a fundamental study of fluidic thrust vectoring, a method of applying a synthetic jet as a secondary flow to control the direction of the primary jet and adjusting the deflection characteristics by frequency has been proposed. However, in most cases, the primary jet is a steady continuous jet, so the concept of a phase between the primary jet and the secondary flow did not exist. There are only a limited number of reported studies on the relationship between jet deflection characteristics and phase, and many aspects remain unclear. However, it is only clear that the deflection characteristics of the jet are highly dependent on the phase.

In this study, a pulsating jet was used for the primary jet, which can easily achieve high flow rates, and a synthetic jet was applied to the secondary flow to experimentally elucidate the flow characteristics. Flow visualization observations and velocity distribution measurements were performed for various dimensionless frequencies under a phase difference of π, the largest jet deflection angle in the previous study. The main result is that under a phase difference of π, the jet direction can be controlled by a dimensionless frequency. When the dimensionless stroke length, which corresponds to the reciprocal of the dimensionless frequency, is large, the vortex formation position is relatively far from the slot outlet, resulting in a small jet deflection. The results show that when the dimensionless stroke length is small, the primary jet is deflected significantly due to vortex formation near the slot outlet, resulting in a near wall jet.

KEYWORDS

Synthetic Jet, Pulsating Jet, Dimensionless Frequency, Phase, Jet Vectoring

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Oral Presentation *Chemical And Environmental Engineering, Climate Change; Fluid Mechanics; Waste Management*

Unsteady Flow Characteristics of Two Plane Synthetic Jets under Interference

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ABSTRACT

Flow control is used not only in power plants, industrial plants, and factories, but also in many other situations that are familiar to many people, such as home appliances, transportation equipment, and the movement of aquatic organisms, insects, and birds. Many researchers have focused on not only the basic flow characteristics of jets but also the directional control of flow. In this field, a method of direction control using the oscillatory characteristics of the excited jet has recently been proposed. Excited jets are jets in which the velocity is varied with time by an oscillating element such as a diaphragm, piezoelectric element, or speaker. Pulsating jets and synthetic jets are typical examples. Therefore, the concept of oscillatory characteristics is present because the flow is inherently unsteady. However, the knowledge of directional control using the mutual interference of multiple excited jets is very limited, and there are few research reports that refer to the quality of the flow produced in this situation.

In this study, two planar synthetic jets were generated and experimental attempts were made to elucidate the flow characteristics under jet interference conditions. We focused on the phase of the two jets and the relationship between the velocity fluctuation characteristics and the phase of the generated flow was investigated from the perspective of evaluating the quality of the jets, based on flow visualization observations and velocity measurements on a reference plane using a hot-wire anemometer. The main conclusion is that the real flow rate generated from flow field measurements at a constant frequency of 36 Hz is phase dependent, and the turbulence in jet velocity (RMS) increases with increasing phase on the reference plane (dimensionless distance 15), with a maximum value of RMS≈0.46 around phase $\varphi=\pi/2$ and decreasing RMS values thereafter. These techniques may be useful for local processing and cleaning. A smaller phase is better when the jet is to be maintained enough downstream, and a larger phase is better when the goal is to improve heat exchange efficiency, such as in cooling.

KEYWORDS

Plane Synthetic Jets, Phase Difference, Velocity Change with Time, RMS, Flow Visualization

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Deflection Characteristics of Main Jet by Circular Cylinder with Double Jet Sheets

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ABSTRACT

The lift generated by the Circulation Control Wing (CCW) can be easily adjusted according to the jet sheet momentum and is said to be suitable for Short Take-Off and Landing (STOL) because it can generate larger lift than conventional flaps. This technology has already entered the practical stage, although only partially. The study of tangential blowing cylinders can be considered as a fundamental study of CCW. The flow around a tangential blowing cylinder in uniform flow, oscillation phenomena near a wall surface, and fluid force characteristics have been investigated and certain results have been obtained. Originally, most of this type of research focused on fluid forces, since the objective was to develop a high-lift force generator. Recently, a method using a tangential blowing cylinder has been proposed for flow direction control, and it has been shown that a very large deflection angle can be obtained compared to conventional methods. However, most of the above studies are concerned with single slots, and there are few reports on multi-slots, and in particular, there is little discussion on jet vectoring using tangential blowing cylinders with multi-slots.

In this study, the relationship between the slot angle and the deflection angle of the primary jet is experimentally investigated mainly to clarify the flow characteristics around a tangential blowing cylinder with multiple slots placed in the primary jet. The primary jet is generated in the wind tunnel, and the deflection angle of the primary jet is adjusted by a tangential blowing cylinder installed downstream. Here, the main focus was on velocity distribution measurements using a hot-wire anemometer and flow visualization observations. The main results are as follows: for the single-slot case, the deflection angle increases with increasing slot angle from 0 to around 150°, but the deflection angle drops sharply after 180°, whereas for the double-slots case, the difference in deflection angle with slot angle is not as large as that for the single-slot case. The maximum deflection angles of the single-slot and double-slots case do not differ significantly for the same momentum coefficient.

KEYWORDS

Jet Deflection, Circular Cylinder, Double Slots, Jet Sheet, Flow Visualization

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Restoration Process of Plane Jets to Flow Disturbances

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ABSTRACT

Research into jet has a long history, and we who live in modern society have benefited greatly from jet technology. Jet is used in a wide range of appliances, from home appliances such as air conditioners, electric fans and hair dryers, to transportation machinery such as automobiles, airplanes, and trains, and also in infrastructure projects, such as controlling the flow in turbines and cooling the core in nuclear reactors. For this reason, further developments in jet technology are expected in the future. Meanwhile, jet research is closely related to the medical field, and recently it has been positioned as fundamental research to elucidate the infection mechanism of COVID-19. In this context, air curtains have attracted attention as one of the measures to prevent droplet infection of COVID-19. An air curtain is a technology that divides an indoor space into multiple areas using a plane jet as a boundary, and has the advantage of imposing extremely few restrictions on humans compared to spatial separation methods using solid walls such as partitions. However, there has been insufficient discussion on the quantitative evaluation of the effectiveness of air curtains, and many unknowns remain, especially regarding the responsiveness of a plane jet to disturbances. In this study, the recovery process of jet velocity fluctuations was primarily investigated numerically by impinging a pair of vortices perpendicularly on a plane steady continuous jet. ANSYS 2021 R1, Fluent (ANSYS, Inc.) was used for the numerical simulations. A two-dimensional incompressible viscous flow was assumed, and the standard k-epsilon model was used as the turbulence model. The computational mesh was approximately 57,000. The disturbance was one period of sinusoidal velocity fluctuation, which was set to collide perpendicularly with the jet. No-slip conditions were imposed on the wall, and constant static pressure conditions were imposed at the flow field exit. The main results showed the velocity vector, vorticity distribution, and jet response characteristics to various disturbances, and the jet showed roughly similar behavior even for different frequencies when the impulse ratio was the same. It was also suggested that the recovery process of the jet velocity fluctuation was roughly similar.

KEYWORDS

CFD, Plane Jet, Flow Disturbance, Vortex Pair, Restoration

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Oral Presentation *Chemical And Environmental Engineering, Climate Change; Fluid Mechanics; Waste Management*

Layout Optimization for Efficient Materials Recovery Facility (MRF): A Systems Simulation-Based Approach

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ABSTRACT

An effective layout for materials recovery facility (MRF) is key to ensuring smooth material flow and reducing unnecessary movement, ultimately leading to a more efficient operation. This study examines three alternative layouts for a medium-scale junk shop to enhance its operational performance, specifically aiming to increase processing throughput, minimize worker movement, and improve worker productivity. Despite a flexible workforce of four, the existing layout suffers from disorganized waste storage, hindering efficiency. Different principles of layout design were applied to develop the three alternatives such as the (1) U-shaped layout, (2) proximity-based layout, and (3) layout with grouped sacking points. Through a systems simulation approach, a computer model of the current operation was built using the FlexSim software. On-site measurements were performed to map out layout dimensions and storage area distances. Retrieval of receipt records, time studies, operator estimates, and management interviews helped in acquiring the input data required. After validating the current model, models for the three alternative layouts were also simulated and replicated for 20 times to ensure statistical significance of comparative results. The U-shaped layout (alternative 1) emerged as the most efficient with the highest throughput of 10,143 units and significantly reduced the worker travel distance by 30%. Notably, this improvement in travel distance resulted in a slight decrease in worker utilization in the chosen alternative. Alternative 1 strategically positions waste storage on the warehouse perimeter, with centralized processing areas for packing and weighing situated in the middle and front of the shop, respectively. Layout optimization demonstrates effectiveness in boosting efficiency and profitability in waste processing facilities. The demonstrated approach can be adapted to similar operations seeking to improve workflow and resource utilization. Future research may also explore other layout design principles in developing the alternatives.

KEYWORDS

materials recovery facility, junk shop, layout optimization, simulation-based design, operational efficiency

MATERIALS ENGINEERING, MANUFACTURING, AND MECHANICAL ENGINEERING	
PARALLEL SESSION (DRILON HALL)	**Session chair: JESHA FAYE T. LIBREA** **Co-chairs: BUTCH G. BATALLER** **MARITA NATIVIDAD T. DE LUMEN**
10:00 - 10:10	**ISAT23.0068** | **Tsubasa Abe** | *Robust Path Planning in Unknown Environments Minimizing Detours and Backtracking*
10:10 - 10:20	**ISAT23.0071** | **Seiya Hirota** | *Robot Navigation for Avoiding Local Minimums Through Virtual Wall Generation*
10:20 - 10:30	**ISAT23.0031** | **Kota Ishiwata** | *Transient Behavior of Plane Jet Over Flat Plates*
10:30 - 10:40	**ISAT23.0059** | **Sora Jinnai** | *Design of Monocular Stereo Camera System Using Convex Mirrors for Wide FoV*
10:40 - 10:50	**ISAT23.0024** | **Takeshi Kitazawa** | *Basic study on three-dimensional residual stress estimation using XRD for surface-modified materials*
10:50 - 11:00	**ISAT23.0108** | **Rozen Grace Madera** | *Fabrication of AZO films as piezoelectric material for MEMS-based sensors*
11:00 – 11:10	**QUESTION & ANSWER**
11:10 - 11:20	**ISAT23.0082** | **Kazuhiro Suga** | *Implicit Finite Element Analysis of Braided Self-expandable Colonic Stent*
11:20 – 11:30	**ISAT23.0058** | **Hiroki Matsuno** | *Radiation Intensity Estimation in RPV Based on Prior Knowledge of Fuel Debris*
11:30 – 11:40	**ISAT23.0094** | **Kento Moriya** | *Fabrication of SnSO4 transparent semicon-ductor thin-films using simultaneous oxidation and sulfurization annealing*
11:40 – 11:50	**ISAT23.0028** | **Kazuma Muraoka** | *3D Residual Stress Estimation Using X-ray Diffraction for Surface Damaged Materials*
11:50 – 12:00	**ISAT23.0072** | **Tomohiro Yamaguchi** | *Epitaxial mist CVD growth of oxide and nitride crystal films*
12:00 – 12:10	**ISAT23.0070** | **Yurika Takahashi** | *Autonomous Navigation of Radiation Source Identification Based on Information Criterion*
12:10 – 12:20	**QUESTION & ANSWER**
End of Parallel Session for Materials Engineering, Manufacturing, and Mechanical Engineering	

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Oral Presentation *Materials, Manufacturing, and Mechanical Engineering*

Robust Path Planning in Unknown Environments Minimizing Detours and Backtracking

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ABSTRACT

This study proposes an advanced path planning method considering terrain roughness and dead ends in unknown environments, which is critical for the stable movement of wheeled mobile robots. For ensuring robust navigation over varying terrains, the proposed method employs 3D laser scanners to measure the terrain roughness and utilizes the A* algorithm to generate optimal paths that avoid excessively rough areas, thereby safeguarding the stability of the robot during transit.

The method introduces two key improvements: (a) the robot avoids traversing rough areas consecutively, which reduces the likelihood of excessive vibrations or potential damage, and (b) once a rough area has been crossed, the robot is designed not to backtrack over that same location, thus preventing unnecessary retracing of paths and improving overall path efficiency. However, this strategy also leads to instances where the robot encounters terrain roughness higher than what it faced in the initial pass through the area, due to the avoidance of consecutive rough spots. Despite this, the overall path length was found to be shorter than in previous implementations, underscoring the enhanced efficiency of the new approach.

Simulation results validated that the proposed method substantially improved the robot's ability to navigate unknown environments with varying terrain conditions. The robot effectively avoided consecutive rough areas, mitigated unnecessary backtracking, and thereby achieved a more efficient and stable path. Additionally, the method proved effective in handling scenarios involving dead ends, where the robot can return to a safer location and recalibrate its path accordingly. The reduction in path length compared to earlier implementations was particularly notable, demonstrating the effectiveness of the proposed method.

This study offers a robust solution for improving the stability and efficiency of mobile robots in unknown environments by addressing the challenges posed by terrain roughness and dead ends. Our future works will involve integrating this system with real-world roughness estimation techniques using 3D laser scanners and evaluating our system through extensive field experiments.

KEYWORDS

Path Planning, Terrain Roughness, Backtracking, A* Algorithm

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Robot Navigation for Avoiding Local Minimums Through Virtual Wall Generation

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ABSTRACT

Robots have the potential to replace humans in performing tasks, either partially or fully, which can reduce the risks associated with dangerous operations and lower the likelihood of fatigue and human error caused by extended periods of operation. In dynamic environments such as disaster sites, robots need to navigate around obstacles without prior knowledge of environments. As a path planning method in unknown environments, the artificial potential field (APF) method is generally used since it is computationally efficient and allows real-time operation. The APF method generates attractive forces toward the goal and repulsive forces away from obstacles. However, the method is prone to local minimums, where the robot may become stuck as the attractive and repulsive forces balance out.

Previous studies attempted to resolve this issue by creating virtual walls to prevent the robot from getting trapped in local minimums. However, these methods often exhibited inconsistencies in wall generation. The problem stems from how these virtual walls are generated—based on a comparison between a reference line and obstacle data. The choice of reference line can cause significant variations in the wall generation pattern, leading to instability. Additionally, these methods require information about the robot's position relative to the obstacles and the distances between obstacle points, adding complexity to the algorithm.

This study proposes a novel method that eliminates the reliance on the robot's position or distance information between the robot and obstacles. Our approach generates virtual walls in a stable manner, independent of any reference lines, ensuring consistent performance regardless of the robot's position. Comparative results showed that this method reduced computational processing while improving the stability of virtual wall generation, addressing key shortcomings of previous approaches.

Future work will involve testing the proposed method in real-world environments, further validating its effectiveness in dynamic and unstructured terrains. This new approach represents a significant improvement in robotic navigation, particularly for hazardous and unpredictable conditions.

KEYWORDS

Artificial potential field, Obstacle avoidance, Local minimums, Virtual wall generation, Dynamic environments

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Materials, Manufacturing, and Mechanical Engineering

Transient Behavior of Plane Jet Over Flat Plates

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ABSTRACT

Since the outbreak of the new coronavirus, mass infection by viruses and other infectious agents in environments where an unspecified number of people stay for long periods of time in enclosed spaces, such as conference rooms, restaurants, high-speed railcars, and airplanes, has become a problem. This has led to increased interest in room ventilation and the development of jet stream technology to realize innovative ventilation and air conditioning of enclosed spaces. Related to this issue, the flow characteristics of jets passing over two-dimensional flat rows have recently been investigated, and the relationship between the flat row geometry and the flow inside the cavity has been discussed. However, previous studies have only examined the flow in a well-developed condition, and no reference has been made to the development process of the jet flow, leaving many unknowns regarding the transient behavior of the jet flow.

As a fundamental study for improving ventilation and air conditioning technology for enclosed spaces, this study investigated the effect of the offset ratio of the jet outlet slot on the internal cavity flow, focusing on the transient behavior of the flow, by modeling the room or cabin as a flat plate row. Numerical simulations and visualization experiments of the flow field using the smoke wire method were performed. The numerical simulation code used was ANSYS Fluent, and the standard k-ε model was applied as the turbulence model, with a mesh count of approximately 60,000. A hot-wire anemometer was used to set the experimental conditions, and the flow field was photographed with a high-speed camera using a laser as a light source. The main results obtained in this study are that, under the conditions of this study, the jet flow passing over a row of plates generally moves straight from beginning to end when the offset ratio is small, and when the offset ratio is large, the jet flow initially moves straight but is pulled toward the plate row with time, and the time required for flow development increases as the offset ratio increases. The time required for flow development increases with the offset ratio.

KEYWORDS

Plane Jet, Flat Plates, Transient Behavior, CFD, Flow Visualization

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Design of Monocular Stereo Camera System using Convex Mirrors for Wide FoV

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ABSTRACT

This study investigates the effect of different mirror shapes on sensing performance of a monocular stereo camera. Currently, stereo cameras are used as sensors to recognize the environment in front of mobilities. According to Japanese traffic accident statistics, about 60% of accidents were caused by delayed detection. To solve this problem, conventional systems use multiple cameras to detect environments in all directions. However, it leads to high cost of camera systems.

This study proposes a monocular stereo camera system using convex mirrors for wide sensing range. The use of convex mirrors provides a wide sensing range. However, image distortion is greater than conventional systems using planar mirrors. It has been reported that image distortion significantly reduces measurement accuracy. To solve this problem, the proposed method applies an image processing algorithm that includes distortion correction, feature point extraction, stereo matching, and distance calculation.

We evaluate the distance accuracy and sensing range of a monocular stereo camera system with different mirror shapes and configurations. As mirror shapes, planar and convex mirrors are used. As mirror configurations, we define three parameters: distance between the camera and mirrors, pitch angle between the camera and mirrors, and angles (pitch and yaw) between the two mirrors. We set up the camera system according to each condition and evaluate sensing performance (accuracy, sensing distance, and field of view) of the system.

The camera system measured the distance to a target object while moving the target in 1 m increments in the range of 1 m to 20 m. As the experimental conditions, the two mirror shapes and the five configuration parameters were defined. The results showed that the mirror shapes and configurations significantly affected the sensing performance of the camera system. Moreover, the result demonstrated that the proposed camera system using convex mirrors achieved a wider sensing range compared to that of previous camera systems.

KEYWORDS

Monocular stereo camera, Autonomous driving sensors, Advanced driver assistance systems (ADAS), Convex mirror, Low-cost sensing technology

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Oral Presentation *Materials, Manufacturing, and Mechanical Engineering*

Basic study on three-dimensional residual stress estimation using XRD for surface-modified materials

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ABSTRACT

Residual stresses generated during machining affect the dimensional accuracy and fatigue strength of structures. On the other hand, adding compressive residual stress through surface modification processing such as laser peening can improve fatigue strength. Understanding the relationship between various surface modification processing conditions and residual stresses makes it possible to consider high-precision processing methods and assess fatigue life. However, the X-ray diffraction (XRD) can only measure the surface residual stress. Repeating electropolishing and XRD to measure the residual stress along the thickness direction does not allow the measurement of the original residual stress values, as the residual stress is released by electropolishing. Neutron diffraction requires special irradiation facilities and relatively long measurement time. Only the method using the eigenstrain theory and XRD can assess three-dimensional residual stresses in the field non-destructively.

The aim of this study is to assess the three-dimensional residual stress distribution for surface modification materials with relatively high accuracy using this method. The estimation accuracy of this method is demonstrated by numerical simulation using a relatively simple model.

The inverse analysis in this study estimates the three-dimensional eigenstrain from the two-dimensional elastic strain on the surface. Therefore, the number of unknowns must be reduced appropriately to improve the estimation accuracy of this method. In this study, it was assumed that the eigenstrain is distributed constant in the working direction. The thickness-directional distribution of the eigenstrain in each direction was approximated by a linear combination of several functions. In addition, several ranges of eigenstrain were set in the perpendicular direction of the machining line where the eigenstrain generated during machining was expected to be of the same magnitude, and the eigenstrain was grouped into groups.

As a result of the estimation of this method by numerical analysis, the maximum difference between the correct value and the estimated value was 80 MPa in the near machining areas. This result was within 20% of the generated residual stress, so it obtained high estimation accuracy. In the future, we would like to improve estimation accuracy and conduct demonstration experiments.

KEYWORDS

Mechanical engineering, Eigenstrain, Residual stress, Fatigue, Inverse analysis

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Oral Presentation *Materials, Manufacturing, and Mechanical Engineering*

Fabrication of AZO films as piezoelectric material for MEMS-based sensors

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ABSTRACT

Piezoelectric materials have gained interest in microelectromechanical (MEMS)-based applications such as pressure and surface acoustic wave (SAW) sensors. Lead zirconium titanate (PZT) is a widely studied, promising material due to its excellent piezoelectric properties. However, conventional lead-based piezoelectric materials are highly toxic. Hence, it is essential to seek lead-free alternatives. Zinc oxide (ZnO) nanostructures are considered one of the alternatives due to their low cost, abundance, and non-toxicity to the environment. It is an *n*-type semiconductor material which crystallizes in hexagonal wurtzite structure under ambient conditions. In this work, aluminum-doped ZnO (AZO) thin films were deposited via radio-frequency (RF) magnetron sputtering using a pressed-sintered powder target with 2 wt% dopant concentration. The films were deposited in a pre-cleaned 1.3 cm x 1.3 cm Si (100) and 1 cm x 2 cm glass substrates in an argon environment with an RF power of 150 W and a target-to-substrate distance of 9 cm. The base and working pressures used were 0.9 and 9 Pa, respectively. The film thickness was measured at 798 nm. Optical properties showed an absorption at 362 nm with a calculated optical band gap of 3.32 eV. Electrical properties showed a sheet resistance value of 1.18 E+03 Ohm/sq with a resistivity of 9.32 E-04 Ohm-m. The piezoelectric coefficient was measured by a d33 meter with a value of 12.1 pC/N which is within the expected range of 3.0-20.0 pC/N for ZnO films from literature. This work demonstrated the feasibility of preparing AZO thin films via magnetron sputtering in sub-atmospheric conditions using powder targets.

KEYWORDS

MEMS, AZO, thin film, sputtering

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Oral Presentation *Materials, Manufacturing, and Mechanical Engineering*

Implicit Finite Element Analysis of Braided Self-expandable Colonic Stent

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ABSTRACT

In recent years, the application of Bridge to Surgery (BTS), which aims to decompress the colon before curative surgery for obstructive colorectal cancer, has been expanding. In BTS, colon decompression is achieved using a self-expandable metallic stent (SEMS) to dilate the obstructed area. The application of BTS has significantly improved patients' quality of life (QoL) . On the other hand, placing a stent in the colon introduces risks of complications such as perforation and migration.

To quantitatively evaluate the risks of complications and the effects on prognosis due to stent placement, it is essential to assess the mechanical stress the stent exerts on colorectal cancer tissue during the expansion process. However, it is difficult to directly measure mechanical stress during treatment. Therefore, the development of predictive methods using finite element analysis (FEA) is highly anticipated. In FEA, it is necessary to analyze the contact between stents, as well as between the stent and colorectal cancer tissue, and to evaluate the mechanical behavior of materials with different properties, such as superelastic, viscoelastic, and shape memory alloy materials. To achieve stable analysis under these conditions, implicit methods are preferred. However, many previous studies have focused on developing finite element analysis methods using explicit analysis.

To accurately assess the mechanical stress exerted by the stent on colorectal cancer tissue during the expansion process, it is necessary to develop finite element analysis methods based on implicit analysis. This study aims to develop a finite element analysis method for self-expandable metallic stents using implicit methods. This report presents a prototype finite element analysis model for stents based on implicit methods. Numerical experiments are conducted using the prototype model to identify the challenges in the analysis. The stent used in this study is a braided, Cross Type stent, specifically the WallFlex stent.

KEYWORDS

Implicit FEM, Braided Self-expandable Colonic Stent

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Oral Presentation *Materials, Manufacturing, and Mechanical Engineering*

Radiation Intensity Estimation in RPV Based on Prior Knowledge of Fuel Debris

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ABSTRACT

This study proposes a novel method for radiation intensity estimation in a reactor pressure vessel (RPV), focusing on fuel debris retrieval at Fukushima Daiichi Nuclear Power Plants. The investigation inside the primary containment vessel (PCV) is a crucial task for safe and effective fuel debris retrieval. While fuel debris distributed in the pedestal was confirmed in a previous investigation, fuel debris inside the RPV are still unconfirmed. Our research group is planning to insert an investigation unit from the top of the RPV after removing the upper structure of the PCV, and the system measures radiation using gamma-ray detectors and internal structures using cameras.

The proposed method defines the bottom of the RPV as two-dimensional grids and estimates the intensity of radiation sources. As the first step of the proposed method, a database of all distribution cases is constructed. Our investigation system has four robotic arms with non-directional gamma-ray detectors; therefore, the incident number of gamma-rays can be obtained at four positions simultaneously. The first gamma-ray measurements are conducted at predetermined positions. Then, the measurement values of each detector at the predetermined positions for all distribution cases are calculated and saved as the database. By comparing the measurement values with the database, the candidate distributions can be determined. Then, the prior knowledge through numerical simulation is applied. The proposed method leaves only candidates whose error of each source from the prior knowledge is 2 MBq. To evaluate the remaining candidates and leave only one case, additional measurements are conducted at the different positions from the first measurement. The proposed method determines the measurement positions where are possible to maximize the difference between candidate distributions. The proposed method calculates the likelihood of the candidates, and the best one is selected as a final estimation result.

Simulations showed that the proposed method accurately estimated the radiation intensities in the RPV with limited measurement points, potentially reducing radiation exposure for workers and equipment. Various scenarios, including different debris distributions and measurement uncertainties, were tested to validate the method's robustness.

KEYWORDS

Radiation intensity estimation, Reactor pressure vessel, Fukushima Daiichi Nuclear Power Plants

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Oral Presentation *Materials, Manufacturing, and Mechanical Engineering*

Fabrication of $SnSO_4$ transparent semiconductor thin-films using simultaneous oxidation and sulfurization annealing

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ABSTRACT

$SnSO_4$ has a layered structure and is a promising candidate as a p-type transparent semiconductor with band gap of 3.9 eV and hole effective mass of 0.88, theoretically. However, there has been no report on experimental fabrication of the semiconductor thin films. For this reason, we are trying to fabricate $SnSO_4$ thin films and investigate their electrical properties to clarify the possibility of $SnSO_4$ thin films as p-type transparent semiconductors. In this study, $SnSO_4$ thin films were fabricated by simultaneous sulfurization and oxidization of a metal Sn thin film. Here, we report that oxygen pressure during annealing influences on the crystal orientation and the bonding states of $SnSO_4$.

In the first step, metal Sn film was prepared using a thermal evaporator. In the second, both the film and sulfur powder on an alumina boat were installed into the quartz tube. O_2 gas was introduced and then annealed at 300 °C for 30 min. The O_2 pressure during annealing was set at range between 11 ~ 71 kPa. The crystallinity of the film was characterized by an X-ray diffractometer (XRD). The binding states were analyzed using X-ray photoelectron spectroscopy (XPS), and the sheet resistance was measured with four-point probe method.

The orthorhombic phase of $SnSO_4$ was confirmed in all oxygen pressure conditions, and no any crystal structures originating from metallic Sn, SnS_X and SnO_X were recognized. At 51 kPa, a (002) plane was obtained dominantly and the lowest sheet resistance of 432.1 kΩ was recorded. This crystal orientation is parallel to the substrate surface and shows a relative light hole effective mass in the c-axis direction. SO_4^{2-} component was generated reaction with S^{6+} and oxygen atoms during the annealing. We analyzed the *S 2p* spectrum and it can be deconvoluted into four peaks, which include SO_4^{2-} and SO_3^{-} components at the range of 167 ~ 173 eV. With increasing the pressure, increase in the SO_4^{2-} components was observed.

In summary, the XRD result showed that the $SnSO_4$ (002) plane was dominated with increasing oxygen pressure. The obtained XPS spectra also showed that the ratio of SO_4^{2-} components increases as the O_2 pressure increases.

KEYWORDS

P-type transparent semiconductor, Oxide, sulfur, semiconductor materials.

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Oral Presentation *Materials, Manufacturing, and Mechanical Engineering*

3D Residual Stress Estimation Using X-ray Diffraction for Surface Damaged Materials

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ABSTRACT

In electric vehicles, relatively large rolling contact fatigue occurs. Currently, fatigue tests are conducted to evaluate the remaining life with rolling contact fatigue, but these tests are relatively time-consuming and costly. Therefore, if the residual stress generated by rolling contact fatigue can be evaluated, the relative magnitude of rolling contact fatigue can be compared. X-ray diffraction is a non-destructive method to evaluate residual stress, but it can only measure the surface residual stress. When depth residual stresses are investigated by measurement using X-ray diffraction and electropolishing, there is the problem that electropolishing changes the value of the residual stresses. Neutron diffraction can also be used, but is relatively time-consuming and expensive.

Therefore, a three-dimensional residual stress estimation method using X-ray diffraction and strain theory has been proposed. The purpose of this study is to verify the effectiveness of this method by numerical analysis, aiming to estimate the three-dimensional residual stress distribution caused by rolling contact fatigue.

First, an FE model with a finely divided mesh of the contact area is created because the eigen strain generated by rolling contact fatigue occurs in the contact area. In addition, since this method estimates three-dimensional residual stress from two-dimensional residual stress, it is necessary to reduce the number of unknowns. Currently, an FE model with a finely divided partial mesh is created, and a basic study of the method to reduce the number of unknowns is being conducted using a simplified model. In the future, the estimation accuracy of this method should be verified for structures actually subjected to rolling contact fatigue.

KEYWORDS

Mechanical Engineering, Residual Stress, Turning Fatigue, Inverse Resolution, Axial Strain

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Oral Presentation *Materials, Manufacturing, and Mechanical Engineering*

Epitaxial mist CVD growth of oxide and nitride crystal films

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ABSTRACT

Mist chemical vapor deposition (mist CVD) is a recently-developed thin film growth technique with a simple experimental configuration. In the growth by mist CVD, metal complex is first dissolved in water, and this is used as a precursor solution. This solution is atomized by an ultrasonic transducer and transferred to a furnace using a carrier gas. A film can be grown by supplying the atomized particles involving metal complex to substrate. If a single crystalline substrate is set in a furnace, a single crystalline film can also be basically grown on the substrate. Since mist CVD uses water-based solution, this technique has an advantage for growing oxide films. Nevertheless, we have also successfully grown the nitride of Cu_3N film.

In this presentation, the epitaxial growths of oxide and nitride crystal films by mist CVD were introduced with some examples.

High-quality single crystalline In_2O_3, which is one of examples in oxide crystal, is recently expected to be applied to power devices because of their wide band gap above 3.0 eV and superior electrical property with high electron mobility. In_2O_3 is known to have stable cubic (c-In_2O_3) and metastable rhombohedral (α-In_2O_3) structures. In the mist CVD growth of In_2O_3, $In(acac)_3$ is typically used as a metal complex and dissolved in deionized water using a small amount of HCl. When single crystalline cubic yttrium stabilized zirconia (YSZ) was used as a substrate, single crystalline stable c-In_2O_3 film was grown epitaxially on the substrate. When single crystalline sapphire (α-Al_2O_3) was used as a substrate, metastable α-In_2O_3 film with the incorporation of stable c-In_2O_3 phases was sometimes obtained. By increasing HCl concentration in the solution, the a-In_2O_3 film, without the incorporation of c-In_2O_3 phases, was reproducibly grown epitaxially on the α-Al_2O_3 substrate. We found from this result that adding HCl to the source solution was found to affect not only the dissolution of metal complex but also the growth kinetics and dynamics.

We also show the results of the epitaxial growth of nitride and discuss its growth mechanism.

KEYWORDS

Mist CVD, oxide film, nitride film, epitaxy, crystalline

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Oral Presentation *Materials, Manufacturing, and Mechanical Engineering*

Autonomous Navigation of Radiation Source Identification Based on Information Criterion

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ABSTRACT

This study proposes an autonomous navigation method of a mobile robot for radiation source identification. It is necessary to grasp the distribution of radiation sources in advance for human workers who conduct tasks close to radiation sources such as decommissioning the Fukushima Daiichi Nuclear Power Plants. However, there is a risk of radiation exposure when human workers conduct the inspection to grasp the distribution of radiation sources. To solve this problem, an approach using a mobile robot equipped with a gamma-ray detector to estimate the distribution of radiation sources while moving autonomously has been proposed. Conventional methods have been proposed to generate exploration paths, however, they require long exploration times because of inefficient paths.

This study proposes an automatic exploration method using a mobile robot for unknown multiple radiation sources. The proposed method generates a probability map based on the number and direction of incoming gamma rays at unit time. Then, the method generates an exploration path based on entropy. Entropy is one of information criteria that quantifies uncertainty from a probability distribution, where higher entropy indicates greater uncertainty and lower entropy indicates less uncertainty. The proposed method divides an exploration space into grids, and a probability map is created representing the presence of a radiation source in each grid. The probabilities are uniformly distributed, and the probability map is updated so that the probability of the grid corresponding to the direction of incidence of the measured gamma radiation is higher. The entropy of the probability map is then calculated, and the robot moves facing the direction where the entropy decreases the most. The robot can efficiently locate multiple radiation sources by passing between the sources.

Simulation experiments showed that the proposed method successfully estimated the location of the radiation sources. As future work, it is necessary to study the search method when multiple radiation sources exist in the same direction and in environments with obstacles.

KEYWORDS

Radiation source identification, Robot navigation, Information criterion

CIVIL ENGINEERING AND ARCHITECTURE	
PARALLEL SESSION (SAGUIGUIT ROOM)	**Session chair: CHRISTIAN C. VASO** **Co-chairs: EIKO TOMURA** **TAN YIN LING**
10:00 - 10:10 (ONLINE)	**ISAT23.0112 (VIDEO)** | **Richelle Zafra** / Experimental Investigation on Compressive Strength of Fire-Damaged Concrete
10:10 - 10:20	**ISAT23.0044** | **Ariel Miguel Aragoncillo** | *Workability and Flexural Strength of Self-Compacting Concrete with Rice Hull Ash*
10:20 - 10:30	**ISAT23.0027** | **Natsuka Hosoda** | *Technical Development and Design Proposal Using Scallop Shell Sand Mortar for 3D Printer*
10:30 - 10:40	**ISAT23.0017** | **Ayana Suzuki** | *Methods of improving performances of concrete roofshell from the standpoint of SDGs*
15:50 – 16:00	**QUESTION & ANSWER**
10:50 - 11:00	**ISAT23.0045** | **Konan Tsutsui** | *Research on the preservation impact of urban alleys toward a walkable society*
11:00 - 11:10	**ISAT23.0022** | **Nene Uesugi** | *Development of blue carbon PCa concrete components using carbon-fixing marine shell waste*
11:10 - 11:20	**ISAT23.0023** | **Koharu Yokoyama** | *Restoration the Urushi Finishing after Using Watergel for Preventing Fire Spreading*
11:20 – 11:30	**QUESTION & ANSWER**
End of Parallel Session for Civil Engineering and Architecture	

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Oral Presentation *Civil Engineering and Architecture*

Experimental Investigation on Compressive Strength Of Fire-Damaged Concrete

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ABSTRACT

Concrete, known for its high durability to high temperatures, can be significantly damaged by fire. Given the increasing frequency of fire incidents and rising temperatures due to climate change in the Philippines, it is essential to investigate and re-evaluate the compressive strength of concrete exposed to fire. This study investigated the compressive strength of concrete subjected to fire considering factors such as fire intensity, temperature, and exposure duration based on non-destructive tests ultrasonic pulse velocity (UPV) and rebound hammer (RH). The key aspect of this investigation is on the exposure, under controlled heating environment vs. uncontrolled heating environment to simulate the natural fire progression. UPV results under uncontrolled heating set-up show that concrete under temperatures ranging from 150°C to 300°C only have 60% to 68% retained compressive strength. Concrete with temperature more than 300°C exhibited only 40% of its original strength. These concretes were partially damaged with inconsistent intensity and temperature due to the fire's behavior. For concrete under constant core temperature of 400°C, the concrete has 37% of its original compressive strength. On the other hand, rebound hammer test results were found to be inconclusive for concrete exposed to fire for more than 300°C due to the damage in the specimens.

KEYWORDS

Fire-damaged concrete, compressive strength, non-destructive test, ultrasonic pulse velocity, rebound hammer

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Oral Presentation *Civil Engineering and Architecture*

Workability and Flexural Strength of Self-Compacting Concrete with Rice Hull Ash

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ABSTRACT

Self-compacting concrete (SCC) is a type of concrete characterized by its high workability without segregation, allowing it to fill formworks with dense reinforcements and achieve compaction without the need for vibration. Achieving a flowable property requires the use of superplasticizers (SP) and high cement content. The high amount of cement in SCC is a concern due to the environmentally damaging nature of cement production. Rice hull ash (RHA), a pozzolanic material produced from agricultural waste, is a suitable partial replacement for cement due to its high silica content. However, RHA tends to decrease concrete workability, an important property for SCC. In this study, we prepared SCC mixtures with varying amounts of RHA (0, 5%, 10%, and 15% cement replacement by mass) to determine the maximum amount of RHA we can include without significantly reducing its strength. To meet the workability requirements—including filling ability, passing ability, anti-segregation ability, and flowability—the decrease in workability due to the inclusion of RHA was balanced by increasing the dosage of SP. The SCC with 5% RHA showed the best workability test results, achieving the highest passing ability with just a slight increase in SP dosage, from 2.14% of cement weight for the control SCC to 2.55%. It also showed better visual stability as the minor bleeding observed in the control SCC was gone in the SCC with RHA. Using RHA up to 15% replacement is feasible but with a much higher SP dosage of 4.42%. The effect of RHA on SCC strength was investigated using the three-point bending test on the 28th and 56th day of concrete ages. At a 95% confidence level using one-way ANOVA, the 28th-day flexural strength of specimens shows no significant difference at 5% replacement, but reduced strength for 10% and 15% replacement levels. After 56 days of curing, the flexural strength of SCC with 10% RHA replacement level improved, showing no significant difference between the control and 5% RHA replacement. Therefore, the cement in SCC can be partially replaced by RHA up to 10% by mass without significantly reducing concrete strength.

KEYWORDS

Self-Compacting Concrete, Workability, Flexural Strength, Rice Hull Ash

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Oral Presentation *Civil Engineering and Architecture*

Technical Development and Design Proposal Using Scallop Shell Sand Mortar for 3D Printer

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ABSTRACT

In October 2020, the Japanese government announced at an international forum that it aims to achieve a carbon-neutral society by 2050. This announcement has led to increased interest in the use of carbon neutral resources in the Japanese architectural industry. Japan proposed the resource value of white carbon, which is absorbed by cement concrete, and blue carbon, which is absorbed and stored in the marine environment by marine organisms, as the second and third carbon neutral resources after green carbon. Blue carbon is defined in 2009 United Nations Environment Program (UNEP) report. Currently, seaweeds are mainly designated as Blue Carbon. In this study, we focused on scallop shells which have a potential blue carbon resource. Scallop shells discharged from seafood processing plants are partly reused as shell powder. On the other hand, scallop shells are not actively upcycled as a carbon-neutral resource, despite the fact that they are formed from calcium and carbon dioxide in the ocean in a short period of time (only three or four years) and have carbon-fixing properties. In the first step of this study, we will investigate the occurrence of scallop shells in Japan and other Asian countries and the manufacturing process of scallop shell sand. In the second step, we will develop a mortar for 3D printers using scallop shell sand fines discharged in the process of producing scallop shell sand, and conduct evaluation tests of its basic properties. In the third step, based on the basic properties of the mortar, blue carbon infrastructure will be planned in the town of Oumu, Hokkaido, Japan, in order to promote blue carbon resources in the age of carbon recycling. This infrastructure will not only process discarded shells into shell sand, but will also present them to society as a recycled resource with new value. The project presents a new type of infrastructure that will not only have the venous function of a conventional treatment facility, but will also have an arterial function as a center for transmitting the multifaceted value generated from the recycled resources.

KEYWORDS

Mortar, Blue carbon, 3D printer, Scallop shells, Infrastructure

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Oral Presentation *Civil Engineering and Architecture*

Methods of improving performances of concrete roofshell from the standpoint of SDGs

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ABSTRACT

Recently, efforts to achieve carbon neutrality have been made worldwide, however, the building industries still have been emitting a large amount of carbon dioxide. Especially among these activities, concrete used as a building material accounts for 25% of the world's total materials input, although posing a major challenge to the realization of a sustainable society recently. Concrete has been widely used as a structural material in modern architecture because it can be freely formed, is structurally safe and durable at a globally low cost, and if it is paid attention to the basic properties on related living environment, it would be extremely more higher sound insulation, fire resistance, and heat resistance, on the other hand it would be extremely lower daylighting and moisture permeability.

Therefore, it has been used mainly as a limited structural material in modern architecture, and it has been difficult to design with an emphasis on functions and performance related to the other living environments. In this study, we fabricated a concrete shell at 1/100 scale and highlighted issues such as high closure and low translucency when concrete is used as a roof shell of gymnasium. Accordingly, this study focused on the kinds of functions and performances of concrete roof shell, as a comparison, wooden column and beam structure with curtain roofs, and steel column and beam structure with plate roofs based on their respective effectiveness on living environments, and conducted sensory testing and experimental comparisons.

Furthermore considering these results, as the improvement measures for the concrete roof shell, by adding area of openings to some extend in the concrete roof shell, we evaluated the improvement potential of concrete roof shell in terms of light transparency and humidity control, in additions investigating sustainability indicators such as low carbon and resource utilization ratio, and summarized the comprehensive evaluation properties, and while there is a trade-off relationship between each functions and performances, the importance of considering the balance of the comprehensive evaluation properties was presented from the standpoint of SDGs.

KEYWORDS

SDGs, Living Environment, Building Material, Concrete Roof Shell, Function and Performance Evaluation

23rd International Symposium on Advanced Technology
Engineering Innovations for Net Zero: Advancing Low Carbon Strategies
ISAT-23

Oral Presentation *Civil Engineering and Architecture*

Research on the preservation impact of urban alleys toward a walkable society

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ABSTRACT

Creating human-scale spaces helps reduce the use of automobiles. In other words, creating walkable society is thought to contribute to advancing low-carbon in units of area. We define walkable space as a street with people's activities. In this context, Japanese alleys are precious human scale spaces. These are so narrow that cars cannot pass through. However, alleys are considered as dangerous passageways from the perspective of disaster prevention in Japan. As a result, alleys are being widened and disappearing. We believe that it is necessary to preserve alleys and to realize a walkable society while taking advantage of their benefits in Japan. The purpose of this study is to analyze the relationship between the elements of the alleys and people's activities, and to clarify alley's preservation impact. We also aim to contribute to the advancing walkable society. The study methodology is as follows. First, we make a hypothesis that activity within the alley is generated by the number of buildings and occupied objects that appeared in the alleys. Next, we will conduct an observational research and analysis based on the hypothesis. We also conduct research and analysis from the perspective of link-and-place theory proposed by Peter Jones in the UK. Finally, we will clarify preservation impact from these results. We conduct case studies in Nihonbashi Muromachi and Uchikanda, Tokyo. From the results of the research and analysis, we find that there tends to be more activity in alleys with a higher number of buildings and types of occupied objects. Furthermore, signage and flowerpots which appear in the alleys are particularly likely to encourage activity. Based on the above, we discuss about preservation impact of urban alleys toward a walkable society as follow. (i) Preserving the number of buildings and the occupied objects on the alley will contribute to encouraging activities. (ii) Creating activity in the alley and makes it a human-scale space by preservation. This will reduce automobile traffic. (iii) Preserving alleys will create the space with activity and the street which is enjoyable to walk. This will encourage people to choose walking as their means of transport.

KEYWORDS

Alley, Human-scale, Walkable, Link and Place

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Oral Presentation *Civil Engineering and Architecture*

Development of blue carbon PCa concrete components using carbon-fixing marine shell waste

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ABSTRACT

The concrete industry has been requiring to produce large quantities of cement since 1960's, although these are natural depletion materials, and moreover emits large amounts of material-derived carbon dioxide. Toward the future environmentally friendly concrete needs to be developed to achieve a carbon-neutral society.

By the way, many algae in the sea absorb carbon dioxide in the ocean water and were defined as blue carbon by a United Nations Environment Program (UNEP) in 2009. By the way, Japan plays a great importance role on the sustainability of its diverse fisheries resources, and in the Hokkaido region, approximately 400000 tons of scallops is landed annually, and the shells of them, which account for about 50% of the total weight, are being recycled as downcycle materials. In this study, PCa concrete members using these shells as fine aggregate for concrete is being developed. In addition, as for scallop shells, which grow among just only three years, so it could be explained as blue carbon scallop shell in a widely sense.

The previous our studies have confirmed the fresh and mechanical properties of concrete using shell sand, which has the potential to be low-cost on an actual equipment basis in market. This scallop shells fine aggregate is mainly composed of calcium carbonate ($CaCO_3$) and have a layered structure, which would be cleared to have a high capacity to resist external bending forces and impacts from the outside in concrete materials.

In this study, focusing on the superior high mechanical properties of scallop shells in concrete due to their complex structure and material composition, the study on the durability properties such as carbonation resistance, length change and freeze-thaw resistance were conducted to evaluate by using concrete specimens. Toward the near future, in order to realise the development of building materials that can be expected to contribute to society through low carbon, while enhancing the linkage between the food system using scallop with marine resources and the engineering system as PCa concrete component materials in Japan.

KEYWORDS

Scallop shell, Concrete, Carbon neutral, Durability properties, Blue carbon

23rd International Symposium on Advanced Technology
Engineering Innovations for Net Zero: Advancing Low Carbon Strategies
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Oral Presentation
Civil Engineering and Architecture

Restoration the Urushi Finishing after Using Watergel for Preventing Fire Spreading

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ABSTRACT

In Japan traditional architecture, Japanese lacquer (Urushi) which has a unique luster, durability, and robustness, has long been used as a high-quality coating material that is indispensable for major historical buildings, such as the World Heritage Site, Kyoto/Nara Temple or Shrine. There are several ways to finish the lacquer surface, such as mixing pigments into lacquer to create black lacquer or vermilion lacquer, or applying gold leaf.

Furthermore, Buddhism has widely been believed in Japan, and there are numerous cultural asset Buddhist statues enshrined in temples throughout the country. Most Buddhist statues are made using the dry-Urushi technique, in which a mixture of Urushi and wood powder is heaped up.

The purpose of this study is to investigate an effective method for removing the white solidified matter that forms after drying of a high-viscosity liquid developed to prevent the spread of fire on lacquered buildings and dry-Urushi Buddhist statues. Traditional buildings such as cultural properties are damaged by also water and need to protect their surfaces in case of fire. If the white solidified matter remains on the unique color and luster of Urushi, it is detrimental to the preservation of the value as a cultural asset. Therefore, it is necessary to consider an effective method of removing the white solidified matter.

First of all, we investigated the painting process of Urushi used in cultural property architecture and the dry-Urushi Buddhist statues stored inside it. Since cultural properties are often kept in a state where the surface has deteriorated to some extent due to aging, there is a large possibility that high-viscosity liquid will directly affect the deteriorated surface in the event of a fire. Therefore, the effectiveness of removing white solidified matter was confirmed using deteriorated lacquer test pieces. The white solidified matter was confirmed to remain on the uneven surfaces of the deteriorated lacquer surface even after wiping. We then evaluated whether there were any problems with the formation of the repaired surface during the process of repairing the lacquer test pieces after the white solidified matter was wiped off, through interviews with an Urushi special craftsman.

KEYWORDS

lacquer coating, fire prevention, fire spread prevention, cultural assets, historic building

AGRICULTURE AND FOOD SECURITY, ENERGY PRODUCTION, AND INFORMATICS	
PARALLEL SESSION (DRILON HALL)	**Session chair: MARION LUX Y. CASTRO** **Co-chairs: KANTA TACHIBANA** **DIANA MARIE R. DE SILVA**
13:00 - 13:10 (ONLINE)	**ISAT23.0019 (VIDEO)** | **Shota Okochi** | *Selection and Effects of Nodes for Superposition Coding in Elastic Optical Networks*
13:10 - 13:20	**ISAT23.0099** | **Yun Ju Huang** | *Garlic Essential Oil Alleviates Depression by Modulating Neurotransmitters and Inflammation in Rats*
13:20 - 13:30	**ISAT23.0039** | **Chini Mercado** | *Assessment of Lakatan Banana Fruit Peel Color and Size Characteristics using Image Analysis*
13:30 - 13:40	**ISAT23.0095** | **Rose Ann Montefalcon** | *Low-Cost Data Loggers for Monitoring Vibration, Temperature and Humidity during Postharvest Handling*
13:40 - 13:50	**ISAT23.0016** | **Hiroki Nagai** | *Water splitting using Photovoltaic Lithium-ion-Battery with Gel-type Electrolyte*
13:50 – 14:00	**QUESTION & ANSWER**
14:00 - 14:10	**ISAT23.0113** | **Yu-Sheng Lin** | *Image-based Classification and Analysis of Hospital Dishes for Nutritional Monitoring and Personalized Care*
14:10 - 14:20	**ISAT23.0034** | **Hiroyuki Abe** | *Cognitive Function in Elderly People and Electroencephalogram Measured by Brain-Computer Interface*
14:20 - 14:30	**ISAT23.0114** | **Nai-Shang Liou** | *Sorting and Grading of Cherry Tomatoes Using Spectral Images*
14:30 - 14:40	**ISAT23.0083** | **Ryosuke Kusama** | *A Non-invasive Prediction of Tooth Root Shape with Statistical Shape Model*
12:10 – 12:20	**QUESTION & ANSWER**
End of Parallel Session for Agriculture and Food Security, Energy Production, and Informatics	

23rd International Symposium on Advanced Technology
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ISAT-23

Oral Presentation

Agriculture and Food Security; Energy Production; Informatics

Selection and Effects of Nodes for Superposition Coding in Elastic Optical Networks

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ABSTRACT

Elastic optical networks (EONs) have gained attention for their more efficient frequency utilization compared to conventional WDM networks. In wireless communications, superposition coding technique has been proposed to allow two signals to transmit at the same frequency, improving frequency utilization. Some studies have applied superposition coding to EONs, demonstrating benefits such as reduced call-blocking probability. However, these studies evaluated the cases where superposition coding is applied across the entire network. If implemented selectively in areas where it is most effective, performance can be enhanced more economically. This study evaluates the effectiveness of selective implementation of superposition coding.

When transmitting two signals using superposition coding in EONs, the source nodes must be the same, and there must be a difference in transmission distance between the two signals. The source node assigns different power levels to each signal, creating a superimposed signal. The neighboring-side destination node that receives the superimposed signal extracts its own signal using successive interference cancellation (SIC) technique. The distant-side destination node demodulates its signal by treating the signal addressed to neighboring-side node as noise. We call nodes with superimposed signal generation and SIC functions Superposition-node (SP-node), and superposition coding is applicable when both of the source node and the neighboring-side destination nodes are SP-node. Demodulation at the distant-side node and signal relay can be performed using conventional nodes without these functions. In this study, SP-nodes are selected and implemented using three selection methods: (1) random selection, (2) selection based on betweenness centrality, and (3) selection based on population. These allow the selection of nodes that are considered important from the perspectives of graph theory or communication demand.

We evaluated the performance of each selection methods through computer simulations using JPN12 topology (12-node, 17-link), which mimics backbone networks. The number of SP-nodes, , was set to 4. Among the three selection methods, population-based method (3) reduced the call-blocking probability the most with a 76.6% decrease compared to the case without superimposed coding. This performance is nearly equivalent to a network where all nodes are SP-nodes, indicating that performance improvements can be achieved economically and effectively.

KEYWORDS

Elastic Optical Networks, Superposition Coding, Successive Interference Cancellation, Node Selection, Reallocation

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ISAT-23
Oral Presentation
Agriculture and Food Security; Energy Production; Informatics

Garlic Essential Oil Alleviates Depression by Modulating Neurotransmitters and Inflammation in Rats

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ABSTRACT

Depression, a leading cause of global disability, affects over 320 million people worldwide and is projected to become one of the top ten contributors to the global burden of disease by 2030, according to the World Health Organization (WHO). Despite the availability of antidepressants, their delayed onset of action and associated side effects often reduce patient compliance. Depression is associated with decreased neurotransmitter levels and elevated inflammatory markers, indicating a complex interplay between neurotransmission and inflammation. Garlic (*Allium sativum L.*), long valued for its anti-inflammatory properties, has shown promise in treating neurological disorders. This study investigates the antidepressant effects of garlic essential oil (GEO) in a rat model of depression induced by unpredictable chronic mild stress (UCMS). GEO (5, 15, and 25 mg/kg) significantly improved depressive-like behaviors, such as sucrose preference, and modulated neurotransmitter turnover in the cortex ($p < 0.05$). Additionally, GEO reduced inflammation by downregulating NLRP3 (NOD-, LRR-, and pyrin domain-containing protein 3), ASC (apoptosis-associated speck-like protein), caspase-1, and IL-1β in the frontal cortex, while also decreasing TNF-α levels in the peripheral system. These findings suggest that GEO exerts antidepressant effects by modulating neurotransmission and reducing the concentration of peripheral inflammation.

KEYWORDS

Depression, Garlic essential oil, Unpredictable chronic mild stress; Inflammation

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Oral Presentation *Agriculture and Food Security; Energy Production; Informatics*

Assessment Of Lakatan Banana Fruit Peel Color And Size Characteristics using Image Analysis

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ABSTRACT

In a market setting, traders subjectively sort Lakatan banana fruits prior to selling; hence, the criteria vary from person to person. This study assessed different Lakatan banana fruit characteristics primarily the peel color and size along with their corresponding market prices, and created a sorting classification model to address the lack of definite standards in the sorting practices. Images of 83 banana fruits were captured using an image acquisition setup. Image processing techniques found in open-source software ImageJ were used to extract peel color properties (hue, saturation, and intensity) and size characteristics (diameter and length). Statistical analysis was performed and significant differences were observed in the mean hue values across green and yellow peel color classifications through the Kruskal-Walis test. Similarly, ANOVA of size characteristics showed that mean diameter and length are significantly different across the small, medium, and large size classifications used by traders. Investigation of corresponding market prices revealed no significant differences across varying peel colors and fruit sizes. Due to the limited use of peel color in the sorting practices of traders, the peel color data was deemed insufficient for the discriminant analysis, hence the study focused on size characteristics. The samples allotted for the size analysis were divided into 70% and 30% training and testing datasets. A total of two features were used to create 3 classification setups of different feature combinations using discriminant analysis.[3] The model that yielded the highest accuracy for size characteristics was the combination of both features including the diameter and length with an accuracy of 92.77%. Results showed that the model created can accurately sort Lakatan banana fruits. Ultimately, the development of software or an application that can utilize the created model is recommended to test its performance in actual conditions.

KEYWORDS

Lakatan banana, sorting classification, image analysis, discriminant analysis

23rd International Symposium on Advanced Technology
Engineering Innovations for Net Zero: Advancing Low Carbon Strategies
ISAT-23

Oral Presentation

Agriculture and Food Security; Energy Production; Informatics

Low-Cost Data Loggers for Monitoring Vibration, Temperature and Humidity during Postharvest Handling

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ABSTRACT

Improper temperature and humidity as well as mechanical stress (e.g. impact, vibration, compression) during postharvest handling and storage of fresh produce is a major contributor to food loss. Poor temperature management and mechanical damage accelerate ripening, increase moisture loss, and reduce shelf life and quality. Monitoring conditions during transport is important in developing methods to improve food supply chains. In this study, low-cost Arduino-based data loggers for vibration and impact (AVI) and temperature and humidity (ATH) were developed. The estimated cost for one unit of an AVI and ATH logger is PHP 10,000 and PHP 5,000, respectively. The AVI logger was enclosed in a 3D-printed flexible shell that mimics the firmness of fresh produce; the ATH logger was mounted on a plastic crate used as a transport container. To evaluate the accuracy of the developed devices, readings from both devices were compared to commercially-available and calibrated instruments. Correction factors for x, y, and z axes of the AVI logger were -0.46 G, -0.07 G, and +1.88 G, respectively. For the ATH logger, temperature and humidity readings were consistent with the accuracy of the sensors (± 0.3 °C and ± 2%, respectively) set by the manufacturer. Preliminary tests showed that the AVI and ATH loggers were functional and low-cost devices for in-situ monitoring of vibration forces, temperature, and humidity in food supply chains. Data from multiple units would provide engineers and scientists with a complete profile of conditions during transport and storage of fresh produce, without the risk of damaging or losing costly instruments. Further tests under field conditions are recommended to thoroughly assess the prototype instruments.

KEYWORDS

Arduino, instrumentation, humidity, temperature, vibration

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ISAT-23

Oral Presentation

Agriculture and Food Security; Energy Production; Informatics

Water splitting using Photovoltaic Lithium-ion-Battery with Gel-type Electrolyte

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ABSTRACT

Hydrogen is ultimately clean, highly efficient, and carbon-free energy with very low environmental impact. We recently reported a photovoltaic lithium-ion-battery (PV-LIB), which can be charged by the solar-light irradiation. The PV-LIB uses two active materials, TiO_2 and $LiCoO_2$ (LCO), on conductive transparent glass electrode for the anode and cathode respectively, and an organically electrolytic solution involving Li ion. In order to assemble an all-solid-state PV-LIB, which has large capacity, long cycle-life, low self-discharge, and high operating voltage, we fabricated a novel type of LIB. The pastes of each active material were prepared by mixing carbon powders, polyvinylidene difluoride, and N-methylpyrrolidone and stirring for 48 h at ambient temperature. The titania paste (2.0 g) was placed on the FTO pre-coated glass substrate (40 × 66 mm^2) with titania thin film and coated on a 36 × 53 mm^2 area of the film by a doctor-blade with 600 µm space. The LCO (1.5 g) paste was dropped on another FTO pre-coated glass substrate (40 × 66 mm^2) and coated on a 36 × 53 mm^2 area of the film by a doctor-blade with 400 µm space. The gel-type electrolyte was prepared by mixing the poly(pyridinium-1,4-diyliminocarbonyl-1,4-phenylene-methylene hexafluorophosphate) with $LiPF_6$. The electrodes with the active materials, titania and LCO, were assembled into a sealed sandwich-type device. The devices were connected to platinized titanium electrodes immersed in a 30 % NaOH aqueous solution. In both cases, hydrogen and oxygen gases generated on each electrode linked to the anode and cathode respectively of the device, occurred with no electric power supply, during irradiation with light from the anode side of the device. Thus, it was revealed that the assembled device has a function as a metal-oxide solar cell which can generate electricity by light irradiation.

KEYWORDS

Photovoltaic lithium-ion-battery, Hydrogen, Water splitting

Oral Presentation

Agriculture and Food Security; Energy Production; Informatics

Image-based Classification and Analysis of Hospital Dishes for Nutritional Monitoring and Personalized Care

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ABSTRACT

In addressing the challenges facing future society, issues such as an aging population, declining birth rates, carbon neutrality, and sustainability have emerged as significant concerns. Currently, industries are undergoing a transformative shift towards automation and smart technology. The concept of Industry 4.0 integrates data with automation to create more human-centered systems, which relies on substantial advancements in both hardware and software infrastructure. This trend is expected to extend into the fields of medicine and healthcare, resulting in increasingly systematic and intelligent hospital environments.

This study presents two concepts of smart machines designed to assist with medication management and nutrition intake management within hospitals. These applications leverage image recognition and robotics technologies. The primary objectives of these innovations are to provide alternative methodologies and enhance operational efficiency through automation. By doing so, they can significantly reduce labor hours and mitigate the risk of errors. Furthermore, these advancements contribute to lower carbon emissions, aligning with broader sustainability goals.

KEYWORDS

Photovoltaic lithium-ion-battery, Hydrogen, Water splitting

23rd International Symposium on Advanced Technology
Engineering Innovations for Net Zero: Advancing Low Carbon Strategies
ISAT-23

Oral Presentation

Agriculture and Food Security; Energy Production; Informatics

Cognitive Function in Elderly People and Electroencephalogram Measured by Brain-Computer Interface

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ABSTRACT

As the world transitions into a super-aged society, early detection of dementia is increasingly crucial. In response, we are conducting research to develop a screening tool using the P300-Speller Brain-Computer Interface (BCI). This technology, which connects the brain to a computer, enables interaction and allows for cost-effective, repeated measurements. We have developed a classifier for dementia cases using the text-based P300-Speller BCI. However, Electroencephalogram (EEG) markers for Mild Cognitive Impairment (MCI) remain inadequately defined. This study aims to identify effective EEG markers for detecting MCI. We performed frequency analysis of EEG responses to visual stimuli presented by the P300-Speller BCI and validated these markers. The study involved 103 patients aged 59 to 90 years from the Department of Geriatric Medicine in Tokyo Medical University Hospital and 41 members aged 61 to 86 years from the Hachioji City Silver Human Resources Center. Participants were categorized into three groups based on their scores on the Japanese versions of the Mini-Mental State Examination (MMSE) and Montreal Cognitive Assessment (MoCA): cognitively normal, mild cognitive decline, and cognitive decline. We compared alpha band component values derived from responses to target and non-target stimuli across different cognitive levels. EEG was recorded from Fz, Cz, Pz, P3, P4, Oz, PO7, and PO8 electrodes based on the extended 10-20 system. As a result of the Kruskal-Wallis test, statistically significant trends associated with cognitive decline were observed at the Fz, Pz, Oz, and PO8 electrodes ($p < .05$). Additionally, multiple comparisons using the Steel-Dwass method revealed significant differences between the cognitively normal group and the other groups at the Fz electrode, and between the cognitively normal group and the mild cognitive decline group at the Pz, Oz, and PO8 electrodes ($p < .05$). These results suggest that alpha band component differences in response to target and non-target stimuli presented by the P300-Speller BCI are effective EEG markers for MCI, which may enhance cognitive function classification using this system.

KEYWORDS

Elderly People, Cognitive Function, Mild Cognitive Impairment, P300-Speller BCI, Electroencephalogram

23rd International Symposium on Advanced Technology
Engineering Innovations for Net Zero: Advancing Low Carbon Strategies
ISAT-23

Oral Presentation

Agriculture and Food Security; Energy Production; Informatics

Sorting and Grading of Cherry Tomatoes Using Spectral Images

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ABSTRACT

Cherry tomatoes are a high-value winter agriculture product in south Taiwan. The quality of cherry tomatoes not only determines their commercial value but also directly influences consumer acceptance. Only cherry tomatoes without surface defects should be sold in the market. Furthermore, high-quality cherry tomatoes should have a high °Brix. Currently, the sorting and grading of cherry tomatoes are performed manually in Taiwan. The sorting procedure removes tomatoes with surface defects and those too small by human visual inspection. The grading procedure, which differentiates tomatoes with high/low °Brix, is performed by measuring the °Brix of selected samples using a °Brix meter. Machine Vision based on RGB images, combined with machine learning algorithms, is a powerful technology for automatically detecting fruit surface defects, reducing the labor cost of the postharvest process. However, the colors of some cherry tomato defects are similar to those of normal surfaces. Moreover, the RGB image only provides information about the fruit's surface color, which cannot directly reflect the °Brix values because these values are primarily associated with the fruit's internal chemical composition. Hyperspectral imaging (HSI) can provide spatial and spectral information across a broad range of wavelengths, making it a powerful tool for assessing and inspecting fruit quality. This study used the HSI data with a wavelength range of 400~1000 nm for sorting and grading cherry tomatoes. Three selected bands were used to create pseudo-RGB images for the Yolov8 segmentation model to detect surface defects of cherry tomatoes (i.e., flesh, black fungus, and white fungus). The average spectrums of intact tomatoes were used to build partial least squares regression (PLSR) models to predict the °Brix of cherry tomatoes. The results showed that the accuracies of the Yolov8 segmentation models for red and orange cherry tomatoes are 92% and 79%, respectively. The R^2 values of PLSR models to predict the °Brix of red and orange cherry tomatoes are 0.92 and 0.90, respectively.

KEYWORDS

Hyperspectral Images, Postharvest Process, Cherry Tomatoes, Sorting and Grading

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Engineering Innovations for Net Zero: Advancing Low Carbon Strategies
ISAT-23

Oral Presentation

Agriculture and Food Security; Energy Production; Informatics

A Non-invasive Prediction of Tooth Root Shape with Statistical Shape Model

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ABSTRACT

Understanding the root shape is essential for appropriate orthodontic treatment. A prediction method of root shape using the statistical shape model (SSM) has been proposed. The method predicts a root shape from a crown shape non-invasively. However, the method has not sufficient prediction accuracy because the number of shape representation points is small and their placement is not optimized for SSM. This study develops a SSM for tooth root shape prediction through optimizing the number of shape representation points and their placement. A numerical evaluation of prediction accuracy is carried out.

KEYWORDS

Orthodontics, Tooth Root, Statistical Shape Model, Non-invasive Prediction

ELECTRICAL ENGINEERING, ELECTRONICS, AND ROBOTICS	
PARALLEL SESSION (DRILON HALL)	**Session chair: GENEV YESIREE R. GARCIA** **Co-chairs: SHINYA AIKAWA** **ADRIAN A. BORJA**
14:50 - 15:00 (ONLINE)	**ISAT23.0029 (VIDEO)** | **Toshihiro Yokogawa** | *Improvement of Copper Thin Film Adhesion on PTFE Surfaces Irradiated with C+ and O+ Ions*
15:00 - 15:10	**ISAT23.0052** | **Qian-Bei Hong** | *Parallel Knowledge Distillation for Neural Networks in SSVEP-based Brain-Computer Interfaces*
15:10 - 15:20	**ISAT23.0073** | **Ryo Ishikawa** | *Toward thin In2O3 film growth on SiO2/Si substrate by Mist CVD method*
15:20 - 15:30	**ISAT23.0046** | **Kosuke Matsumoto** | *Characteristics of Zr-doped ZnO Thin Films Prepared by Reactive Sputtering*
15:30 - 15:40	**ISAT23.0025** | **Naoya Utsu** | *Electrical and Optical Properties of Ti-doped ZnO Thin Films*
15:40 - 15:50	**ISAT23.0021** | **Hanwool Woo** | *Path Planning in Unknown Rough Environments with Fall Avoidance for Mobile Robot*
15:50 – 16:00	**QUESTION & ANSWER**
End of Parallel Session for Electrical Engineering, Electronics, and Robotics	

23rd International Symposium on Advanced Technology
Engineering Innovations for Net Zero: Advancing Low Carbon Strategies
ISAT-23

Oral Presentation *Electrical Engineering and Electronics; Robotics*

Improvement of Copper Thin Film Adhesion on PTFE Surfaces Irradiated with C^+ and O^+ Ions

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ABSTRACT

Currently, research into the next generation of high-speed communications, known as Post 5G, is being actively conducted. PTFE is an ideal material for next generation high-frequency substrates due to its low dielectric constant and dielectric dissipation factor. However, due to its high releasability, it has problems of poor adhesion to the copper wiring. Since the cause of the poor adhesion is the strong C-F bonds [1], In a previous study, C^+ ion irradiation increased dangling bonds without significantly roughening the PTFE surface. Therefore, in this study, we attempted to improve the adhesion of the Cu film by irradiating PTFE with O^+ ions after C^+ ion irradiation, introducing O into the PTFE surface.

The PTFE adhesive tape (Nitto Denko Corporation, thickness 0.23 mm) attached to a glass substrate was used as the samples. The multi-process coating system (ULVAC Co.) was used for C^+ and O^+ ion beam irradiation and Cu film deposition. The C^+ and O^+ ion beams were output using CH_4 gas form a beamline consisting of a Freeman-type ion source, extraction electrodes, and a mass analyzer. Both ion beams have an energy of 10 keV and a beam diameter of 20 mm. A contact angle meter (DM-300, Kyowa Interface Science Co., Ltd.) was used to measure the water contact angle related to a surface free energy of samples. An imaging X-ray photoelectron spectrometer (KRATOS ULTRA2, Shimadzu Corporation) was used to analyze the chemical state. The electrical resistivity of Cu thin films was measured by the four-point probe method (Model: RG-5, NPS Co., Ltd.). A scratch tester (HEIDON-22, Shinto Kagaku Co., Ltd.) and a leaser microscope (LEXT OL4500 (OLYMPUS Co., Ltd.)) were used to evaluate the Cu thin-film adhesion rate and surface roughness.

The remaining Cu film (adhesion rate) after the scratch test was calculated from the binarized image of the scratched surface. The sample with C^+ ion irradiation of 112.5×10^{14} ions/cm^2 was 50.4 % in an adhesion rate. The adhesion of the sample fixed with C^+ ion irradiation of 112.5×10^{14} ions/cm^2 improved with the increase in O^+ ion irradiation dose, and the sample with O^+ ion irradiation of 75×10^{14} ions/cm^2 after C^+ ion irradiation had a maximum of 58.4 %. In the future, we plan to investigate the oxygen state after O^+ ion irradiation in detail in order to improve adhesion.

Reference:[1] Kobayashi, Yasuyuki, et al; “Surface Technology”, Direct Adhesion of Fluoroplastic to Copper by Plasma Surface Modification Vol.72, No.6, pp.333-339(2021)

KEYWORDS

PTFE, Surface Modification, C^+ ion beam, O^+ ion beam

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Parallel Knowledge Distillation for Neural Networks in SSVEP-based Brain-Computer Interfaces

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ABSTRACT

A brain-computer interface (BCI) is a crucial tool for enhancing the quality of life for people with disabilities. The steady-state visual evoked potential (SSVEP)-based BCI induces brain activity that corresponds to the frequency of rapid flickering visual stimuli. Traditionally, deep neural networks (DNNs) have been used to predict the frequency of brain responses based on these visual stimuli. However, the performance of these data-driven models can be significantly compromised by interferences such as motion artifacts and equipment discrepancies, which degrade the accuracy of frequency prediction for brain activity. In this study, we propose a parallel knowledge distillation (PKD) approach for DNN architecture to enhance the prediction performance of brain responses. The PKD approach utilizes two parallel teacher models, each trained on different subsets of data, to guide the training of a student model. By leveraging the varying feature extraction capabilities of the parallel teacher models, PKD improves the student model's ability to discern signal features more effectively. The experiments were evaluated on a benchmark dataset of 40 classes. The results show that the PKD-based model significantly enhances the discriminative capability of brain electrical activity compared to baseline models. This improvement in model accuracy enhances the operational effectiveness of SSVEP-based BCIs, providing greater support for people with disabilities.

KEYWORDS

SSVEP, visual stimuli, parallel knowledge distillation

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Electrical Engineering and Electronics; Robotics

Toward thin In_2O_3 film growth on SiO_2/Si substrate by Mist CVD method

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ABSTRACT

Single-crystalline In_2O_3 is recently expected to be applied to power devices because of the wide band gap above 3.0 eV and the superior electrical property with high electron mobility, while polycrystalline and amorphous In_2O_3 are also widely studied to be applied to high-mobility thin film transistors (TFTs).

We have grown a few μm-thick high-quality crystalline In_2O_3 with the high electron Hall mobility of over 200 cm^2/Vs on a crystalline Al_2O_3 substrate by the Mist Chemical Vapor Deposition (Mist CVD). Based on the knowledge obtained to grow the μm-thick crystalline In_2O_3 by Mist CVD, the growth of polycrystalline and amorphous thin In_2O_3 films with a thickness of less than 100 nm was studied on SiO_2/Si substrate.

The Mist CVD is one of CVD methods and is characterized by its ability to grow under atmospheric pressure and simple equipment configuration. In the Mist CVD method, source In-based materials, such as $In(acac)_3$ and In_2O_3 powders, are typically dissolved in deionized water using a small amount of HCl. The source solution is then atomized using an ultrasonic transducer at 2.4 MHz. The formed mist particles are transferred to the substrate set in a quartz furnace using carrier gas, and then In_2O_3 is grown on the substrate. From the results of the crystalline In_2O_3 grown on a crystalline Al_2O_3 substrate, we have found that the excess HCl, other than the HCl added to dissolve the In-based source material, influenced the growth dynamics. For example, the growth rate of crystalline In_2O_3 increased with increasing the amount of excess HCl. Based on this previous findings, the dependence on HCl concentration was evaluated in the growth of polycrystalline (or amorphous) In_2O_3 on SiO_2/Si substrates. We found from this result that the excess HCl influenced the growth rate of In_2O_3, as is the case of the growth on crystalline Al_2O_3. This result suggests that thin In_2O_3 film can be grown by reducing HCl as much as possible, excluding the amount that dissolves the source In-based material.

In this presentation, we report on the growth of In_2O_3 on SiO_2/Si substrate and its effect for reducing HCl in order to obtain thin In_2O_3 film.

KEYWORDS

Mist CVD, In_2O_3, HCl

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Characteristics of Zr-doped ZnO Thin Films Prepared by Reactive Sputtering

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ABSTRACT

Transparent oxides with high electrical conductivity are now used in a wide range of fields and have become indispensable materials for transparent electrodes in various displays and solar cells. Indium tin oxide, which has both high light transmittance and electrical conductivity, is generally used as a material for transparent conductive films. However, indium is a rare metal, and its supply is unstable, so research into alternatives has been active. In this study, zinc oxide, which has a light transmittance equivalent to that of indium tin oxide, was chosen as the base material. By doping this zinc oxide with zirconium, which has a hexagonal close-packed lattice and the same band gap as zinc oxide, the properties as a transparent conductive film were investigated.

Glass (Micro slid glass: Matsunami Glass Industry Co., Ltd.) and Si substrates used as sample substrates were ultrasonically cleaned with ethanol for 10 minutes. Each substrate was mounted on a stainless steel holder and placed in a stocker in the sample introduction chamber of a multi-process coating system (BC5146, ULVAC Corp.). The amount of Zr doping was adjusted by fixing the sputtering rate of Zn and changing the sputtering rate of Zr. The amount of Zr doping in the prepared samples was measured using an energy dispersive X-ray fluorescence analyzer (EDX-7000/8000, Shimadzu Corporation). The light transmittance (UV-Vis) was measured using a UV-Vis spectrophotometer (UV-2550, Shimadzu Corporation) in the wavelength range of 200 to 800 nm. Electrical resistivity and mobility were determined by Hall effect measurement system (HMS-3000, ECOPiA). Crystal structures were measured using a thin-film X-ray diffractometer (XRD: Rigaku Co., Ltd. Smart Lab.) at an X-ray incidence angle of 0.4°.

The amount of Zr doping was varied from 1.45 % to 2.48 %. Transmittance measurements showed an overall increase in transmittance with increasing Zr dope compared to ZnO alone thin films, and Burstein-Moss shift was also observed. The resistivity gradually increased with increasing Zr doping, while samples with lower Zr doping levels were inferred to be n-type degenerate semiconductors based on their carrier concentration. Crystal structure analysis showed that Zr doping reduced the crystallinity of the ZnO samples, which become amorphous when the doping amount exceeded 2 %. In addition, a shift to lower angles was observed at the 002 and 103 peak of ZnO. In this study, Zr-doped ZnO thin films were formed on glass substrates by reactive sputtering and their various properties were investigated. In the future, heat treatment etc. will be necessary to improve the conductivity and transparency.

KEYWORDS

ZnO, Zr, Semiconductor, Transparent Conductive Film

23rd International Symposium on Advanced Technology
Engineering Innovations for Net Zero: Advancing Low Carbon Strategies
ISAT-23

Oral Presentation *Electrical Engineering and Electronics; Robotics*

Electrical and Optical Properties of Ti-doped ZnO Thin Films

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ABSTRACT

Indium Tin Oxide (ITO) is the mainstream transparent conductive film used in liquid crystal displays and other devices. However, zinc oxide (ZnO) has been actively investigated as an alternative material that offers the same performance as ITO. In addition, ZnO is an n-type semiconductor with a wide band gap that can be degenerated by the doping of impurity donors. In this study, titanium (Ti) was used as a doping element in ZnO. In this study, we fabricated Ti-doped ZnO thin films by a room temperature formation process and investigated the optical transmittance, electrical resistivity, and semiconductor properties. Furthermore, to reduce electrical resistivity these films were annealed at different temperatures in a vacuum and at regular atmosphere conditions.

The sample substrates were micro slide glasses (15 x 10 mm in a size) and silicon plates that were ultrasonically cleaned with ethanol for 10 minutes. The oxide thin films were deposited by reactive sputtering using the multi-process coating system (BC5146, ULVAC Corp.). The deposition conditions were a Zn sputtering power of 20 W and a Ti sputtering power of 120 W with an Ar gas flow rate of 20 sccm and an O_2 gas flow rate of 5 sccm to obtain a film thickness of 100 nm. The amount of Ti doping in the prepared samples was measured using an energy dispersive X-ray fluorescence analyzer (EDX-7000/8000, Shimadzu Corp.). Next, for optical properties, the transmittance was measured using a UV-visible spectrophotometer (UV-2550, Shimadzu Corp.). Semiconductor parameters for resistivity, mobility, and carrier concentration were measured using a Hall effect analyzer (HMS-3000, ECOPiA). The crystal structure analysis was performed by X-ray diffraction (SmartLab, Rigaku Co., Ltd.) at an X-ray incidence angle of 0.4 degrees. Finally, the emission spectrum was analyzed by a PL measurement system (HR800, HORIBA, Ltd.).

The sample with Ti-doping at about 2 at.% into ZnO and annealing at 100-200 °C, showed the increase of the optical transmittance in the visible light region which was able to be maintained at 85 %. In the vacuum annealing treatment, the resistivity decreased from 10^{-2} to 10^{-3} Ωcm. The annealing created oxygen defects and increased the crystallite size, which is thought to have increased the mobility and carrier concentration, leading to the lower resistivity.

KEYWORDS:
Transparent Conductive Thin Films, Zinc Oxide, Titanium, and Reactive Sputtering

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Oral Presentation *Electrical Engineering and Electronics; Robotics*

Path Planning in Unknown Rough Environments with Fall Avoidance for Mobile Robot

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ABSTRACT

For exploration in disaster sites, a reliable path planning method is strongly required. Especially in environments where wireless communication is difficult, such as inspection inside the buildings of the Fukushima Daiichi Nuclear Power Plant, robots need to generate safe paths autonomously.

The proposed method applies a rapidly-exploring random tree (RRT) method, which is fast and inexpensive in high-dimensional spaces for path planning. The originality of the proposed method is to consider sudden change in slope which may cause a robot to fall. The proposed method compares an inclination of adjacent slopes and eliminates paths from the candidates when there is a sudden change in slope. Compared to previous methods that evaluate the robot's climbing potential by considering only individual slope angles, the proposed method can generate reliable paths by focusing on continuous changes in slope.

Since this study assumes an exploration in an unknown environment, it is possible that the selected path will be a dead end. To solve this problem, the proposed method defines the area within a certain distance from the goal as a prohibited area if there is no path closer to the goal than the current node. Then, the robot moves to the path closest to the goal outside the prohibited area as moving through an already generated path. Then, a new path to the goal is generated from the current position of the robot. This approach allows for robust path planning ability in complex and unknown environments.

Simulations were conducted based on the assumption that there was no moving obstacle. An environment used in the simulation was uneven terrain that included both gentle and steep slopes, including areas with sudden change in slope where a robot may fall. Under the same condition, the moving distance to the goal with the proposed method was 51.84 m compared to that of the previous method was 147.96 m. Moreover, the robot did not fall through the simulation. This result demonstrates that the proposed method can generate safe and efficient paths in unknown rough environments.

KEYWORDS
Path Planning, Rough Terrain, Fall Avoidance, Rapidly-exploring Random Tree

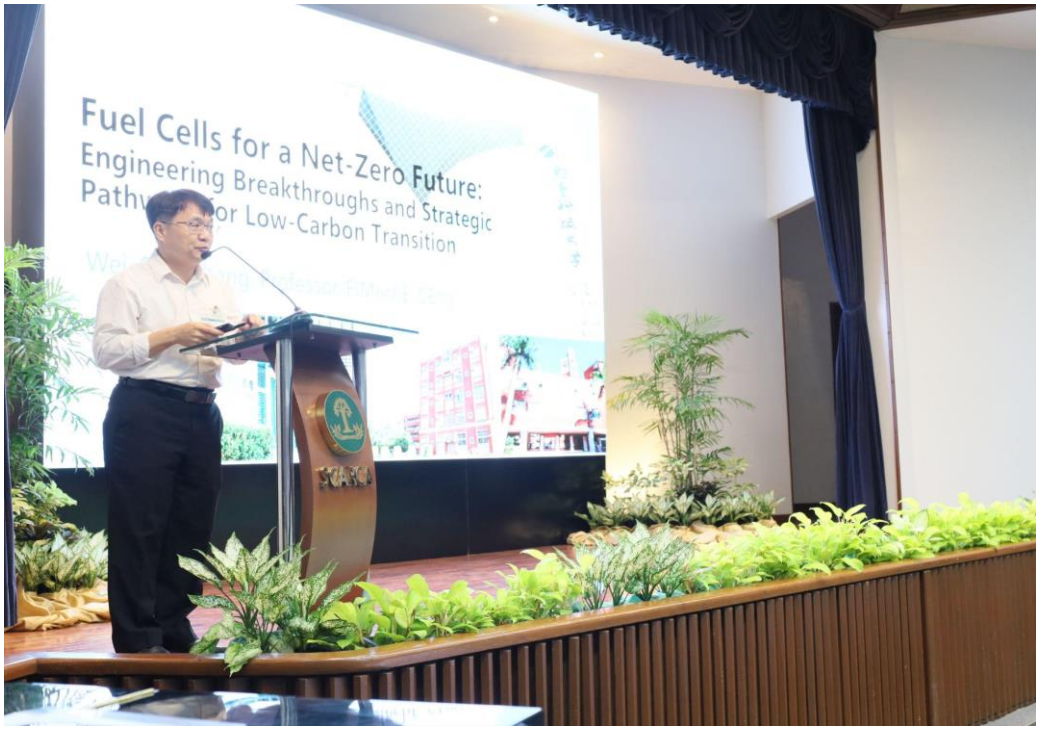
POSTER PRESENTATIONS

POSTER PRESENTATIONS	
JUDGES:	**ROSSANA MARIE C. AMONGO** **ARNOLD R. ELEPAÑO** **MYRA G. BORINES** **YUJI SAKAI** **RODOLFO C. CAMACLANG** **MASAKI TAMURA** **KENJIRO SUGIYAMA**
10:00 - 10:10 (ONLINE)	**ISAT23.0036 (VIDEO)** | **Ren Inoue** | Synthesis of Peptidic Inhibitors with the use of Several Reagents
10:10 - 10:20 (ONLINE)	**ISAT23.0035 (VIDEO)** | **Taeko Kakizawa** | Enzymatic Cleavage and Sequence Determination of Peptide Libraries
10:20 - 10:30 (ONLINE)	**ISAT23.0037 (VIDEO)** | **Taeko Kakizawa** | Preparation of Peptides with Modified Lysine Residues as Enzyme Inhibitors
10:30 - 10:40 (ONLINE)	**ISAT23.0111 (VIDEO)** | **Hoang Trung Hieu Nguyen** | Effects of auxin and cytokinin on callus formation of Vietnamese ginseng (Panax vietnamensis Ha et Grushv.)
10:40 - 10:50 (ONLINE)	**ISAT23.0040 (VIDEO)** | **Efren Paul Arevalo** | Estimation of Sediment Load of Iponan River, Misamis Oriental, Philippines Using Empirical Equation and SWAT+ Modeling
10:50 - 11:00 (ONLINE)	**ISAT23.0103 (VIDEO)** | **Trinh T.D. Pham** | Effects of bonding agents and nanosilica on the properties of biopolymer films
11:00 AM ONWARDS: ONSITE POSTER PRESENTATIONS	
1	**ISAT23.0038** | **Shunya Sato** | *Separation method of potassium chloride and sodium chloride using magnetic field*
2	**ISAT23.0095** | **Rose Ann Montefalcon** | *Low-Cost Data Loggers for Monitoring Vibration, Temperature and Humidity during Postharvest Handling*
3	**ISAT23.0033** | **Miku Yoshizawa** | *Optimization of gold recovery using bipolar electrodes with thiourea coordination*
4	**ISAT23.0076** | **Sydney De Leon** | *Parametric Study on the Bioextraction of Polyhydroxybutyrate (PHB) Biodegradable Plastic from Simulated Biomass using Black Soldier Fly Larvae Alexander*
5	**ISAT23.0091** | **Gewelle Mae Punzalan** | *Coconut Water as a Carbon Source for Sustainable Polyhydroxyalkanoate (PHA) Bioplastic Production by Cupriavidus necator KCTC 2649*

POSTER PRESENTATIONS
(Continued...)

JUDGES:	**ROSSANA MARIE C. AMONGO** **ARNOLD R. ELEPAÑO** **MYRA G. BORINES** **YUJI SAKAI** **RODOLFO C. CAMACLANG** **MASAKI TAMURA** **KENJIRO SUGIYAMA**
6	**ISAT23.0090** | **Jaren Tulipan** | *Enhanced Poly(3-hydroxybutyrate) Bioplastic Production in Cupriavidus necator KCTC 2649 via Fed-batch Culture with Glucose as Substrate*
7	**ISAT23.0080** | **John Rafael Unlayao** | *Valorization of Eucheuma denticulatum hydrolysate as a Potential Substrate for Polyhydroxyalkanoate (PHA) Bioplastic Fermentation*
8	**ISAT23.0057** | **Hiroaki Kawaguchi** | *Creating Sustainable Urban Parks through Rainwater Harvesting and Station Design*
9	**ISAT23.0085** | **Yuna Nakagawa** | *Research on small places in the city of Tokyo*
10	**ISAT23.0044** | **Ariel Miguel Aragoncillo** | *Workability and Flexural Strength of Self-Compacting Concrete with Rice Hull Ash*
11	**ISAT23.0086** | **Shuka Saito** | Research on urban design methodologies for turning central Tokyo into a more walkable city
12	**ISAT23.0030** | **Yui Shioda** | *Seaside Stage by Reusing Abandoned Ships: A Southeast Asian Solution to Environmental Problems*
13	**ISAT23.0050** | **Shotaro Yamazaki** | *New Logistics City*
14	**ISAT23.0109** | **Yuta Miura** | *Analysis Method of 3D Cochlea Structure*
15	**ISAT23.0026** | **Kaoru Oki** | *Run-Length Limited Codes for High-capacity Information Storage Devices*
16	**ISAT23.0051** | **Chisato Tsukioka** | *Stability of Source Solution with Ethylenediamine in Cu3N Growth by Mist CVD*
17	**ISAT23.0069** | **Shigeo Aizawa** | *Comparison of Deep Learning Algorithms for Palm Print Recognition*
18	**ISAT23.0084** | **Yutaka Aoyama** | *Classification of Gait Cycle of the Elderly People using Media Pipe*

POSTER PRESENTATIONS *(Continued...)*	
JUDGES:	**ROSSANA MARIE C. AMONGO** **ARNOLD R. ELEPAÑO** **MYRA G. BORINES** **YUJI SAKAI** **RODOLFO C. CAMACLANG** **MASAKI TAMURA** **KENJIRO SUGIYAMA**
19	**ISAT23.0056** | **Yusuke Hara** | *Emotion Prediction from Facial Expressions During Aggressive Driving Simulator*
20	**ISAT23.0067** | **Shunsuke Hirayama** | *Enhancing Medication Adherence through AI-driven Communication Strategies*
21	**ISAT23.0089** | **Chih-Yuan Hsu** | *Automated Optical Inspection Micro-Adjustment Mechanism for Smart Manufacturing*
22	**ISAT23.0096** | **Kentaro Kanari** | *The Relationship Between Fundamental Frequencies of Japanese Single Sound Pronunciation and Aging*
23	**ISAT23.0018** | **Keita Kodama** | *Improved statistical integrated analysis method for microRNA and gene expression*
24	**ISAT23.0063** | **Hikaru Mito** | *Enhancing Medication Adherence with Self-Mirror Image Reminders: A Solution for Younger Adults*
25	**ISAT23.0079** | **Yuki Ueda** | *K-means Clustering Methods for Large-Scale Fire Spread Prediction in Urban Area*
26	**ISAT23.0081** | **Thi Thuy Hang Phan** | *The Effect of Nanosilica on the Characteristics of Acrylic Coating*
27	**ISAT23.0064** | **Ruito Sugiyama** | *Visualization of robot path planning based on human decision-making mechanisms during encounters*
28	**ISAT23.0092** | **Jaren Tulipan** | *Biodegradable Plastic Film Production from Polyhydroxybutyrate (PHB) using Green Solvents via Solvent Casting Method*
29	**ISAT23.0066** | **Jaren Tulipan** | *PHAper Coats: Bilayer Composites of Cellulosic Paper and Polyhydroxyalkanoate (PHA) Biodegradable Plastic*
30	**ISAT23.0088** | **Gerald Aguilar** | *Polyhydroxyalkanoate production by lake bacteria isolated from the sediments of Laguna de Bay, Philippines*
End of Poster Presentations	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What are the roles of Engineers and Scientists in attaining SDGs?


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Genev Yesiree R. Garcia
Co-chairs:
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