UNIVERSITY OF LAGOS

FACULTY OF ENGINEERING INTERNATIONAL CONFERENCE 2026



BOOK OF ABSTRACTS

FEIC 2026

Innovations for Sustainable Development and Resilient Infrastructure

18th – 20th November 2026

Faculty of Engineering, University of Lagos, Akoka, Lagos, Nigeria

Hybrid Conference: in person and online

BOOK OF ABSTRACTS

Faculty of Engineering International Conference 2026 (FEIC 2026)

Theme: Innovations for Sustainable Development and Resilient Infrastructure

18th – 20th November 2026

Faculty of Engineering, University of Lagos, Akoka, Lagos, Nigeria

Hybrid conference (in person and online)

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Message from the Dean, Faculty of Engineering

Prof. Samson O. Adeosun

Dean, Faculty of Engineering, University of Lagos (Host)

Distinguished guests, colleagues, ladies and gentlemen,

It is my great pleasure, on behalf of the Faculty of Engineering, University of Lagos, to welcome you to the Faculty of Engineering International Conference (FEIC 2026). As Host, the Faculty is delighted to receive researchers, academics, industry practitioners and students, here in Akoka and online, for three days of scholarly exchange from 18th to 20th November 2026.

The theme of the conference, “Innovations for Sustainable Development and Resilient Infrastructure”, goes to the heart of what engineering is for. Roads and bridges, power and water systems, health technologies, communication networks and the industries that sustain our economy all depend on sound engineering. As Nigeria and Africa face rapid urbanisation, a changing climate and pressure on scarce resources, our profession is called upon not only to build, but to build wisely, affordably and for the long term.

The nine departments of the Faculty, namely Biomedical; Chemical; Civil and Environmental; Electrical, Electronics and Computer; Mechanical; Metallurgical and Materials; and Petroleum and Gas Engineering, together with Surveying and Geoinformatics and Systems Engineering, are all represented in this programme. The 73 peer-reviewed abstracts in this book show the breadth and quality of current engineering research, and the value of bringing these disciplines into conversation with one another and with industry.

I am grateful to the Vice-Chancellor, Professor Folasade T. Ogunsola, OON, FAS, for the support given to this conference and to research in the Faculty. I commend the Chair of the Local Organizing Committee, Professor P. O. Oluseyi, and the members of the Committee for their dedication, and I thank our keynote speakers, the reviewers, the session chairs and rapporteurs, and every author who submitted work.

I invite you to make the most of the sessions, the discussions and the opportunities for collaboration that this conference offers. Welcome to the Faculty of Engineering, University of Lagos; I wish you a fruitful and memorable conference.

Prof. Samson O. Adeosun

Dean, Faculty of Engineering, University of Lagos

Welcome from the Chair, Local Organizing Committee

Prof. P. O. Oluseyi

Chair, Local Organizing Committee, FEIC 2026

Distinguished guests, colleagues, ladies and gentlemen,

On behalf of the Local Organizing Committee, it is my pleasure to welcome you to the Faculty of Engineering International Conference (FEIC 2026), hosted by the Faculty of Engineering, University of Lagos, from 18th to 20th November 2026.

Our theme, “Innovations for Sustainable Development and Resilient Infrastructure”, speaks to a central challenge of our time: how engineers can design, build and maintain the systems on which society depends, in ways that serve people today without compromising the generations to come. For Lagos, for Nigeria and for Africa, this challenge is immediate. Our cities are growing, our climate is changing, and our infrastructure must do more with less.

Over the next three days, 73 peer-reviewed papers will be presented across nine engineering subthemes, from civil, environmental and geomatics engineering to electrical, biomedical, chemical and materials engineering. The conference is held in a hybrid format, so that colleagues who cannot be with us in Akoka can still present and take part. We are honoured to host keynote addresses by distinguished scholars from Nigeria, South Africa and Canada, and a panel discussion on turning engineering research into resilient infrastructure and enterprise.

This conference would not have been possible without the support of the Vice-Chancellor, Professor Folasade T. Ogunsola, OON, FAS, and the Dean of the Faculty of Engineering, Professor Samson O. Adeosun, to whom I am sincerely grateful. I also thank our keynote speakers, the reviewers who gave their time and expertise, the session chairs and rapporteurs, the members of the organizing committees, and above all the authors, whose work is the heart of this programme.

I encourage you to attend sessions beyond your own discipline, to ask questions, and to form the collaborations that will carry this work beyond these three days. I wish you a rewarding conference and a pleasant stay at the University of Lagos.

Prof. P. O. Oluseyi

Chair, Local Organizing Committee, FEIC 2026

About FEIC 2026

The Faculty of Engineering International Conference (FEIC) is organised by the Faculty of Engineering, University of Lagos. FEIC 2026 brings together researchers, academics, industry experts and students to share research and practice across the engineering disciplines, under the theme "Innovations for Sustainable Development and Resilient Infrastructure".

Item	Details
Dates	Wednesday 18th – Friday 20th November 2026
Venue	Faculty of Engineering, University of Lagos, Akoka, Lagos, Nigeria. Opening ceremony: Rahman Adisa Bello Hall, Faculty of Engineering, University of Lagos.
Format	Hybrid: in person and online. Times are West Africa Time (WAT, GMT+1).
Chief Host	Prof. Folasade T. Ogunsola, OON, FAS, Vice-Chancellor, University of Lagos
Host	Prof. Samson O. Adeosun, Dean, Faculty of Engineering
Chair, Local Organizing Committee	Prof. P. O. Oluseyi
Papers in this book	73 papers in 9 subthemes; 18 presented online and 2 as posters
Enquiries	feiconference@unilag.edu.ng • https://feic.unilag.edu.ng/

Conference subthemes

Civil & Environmental Engineering: Smart, green and inclusive cities; climate-resilient infrastructure; AI for climate mitigation; renewable energy integration.

Mechanical & Aerospace Engineering: Robotics and human-centric automation; AI-driven manufacturing for circular and low-carbon industry; space systems.

Electrical & Computer Engineering: IoT and sensor networks; energy harvesting; wearables and nanotechnology; cyber-physical security; cloud, edge and distributed computing.

Chemical & Materials Engineering: Green process technology and sustainable materials for African industrial transformation.

Industrial & Systems Engineering: Circular economy and systems thinking; climate action; sustainable AI for resilient economies.

Geomatics Engineering: Positioning and geodesy; remote sensing and image analysis; LiDAR and point clouds; GIS; hydrographic applications.

Energy & Petroleum Engineering: Hydrogen, biofuels and geologic carbon storage; EOR, reservoir modelling and production optimisation; pipeline integrity and flow assurance.

Biomedical Engineering: Machine learning for early disease detection; wearable biosensors; ECG/EEG analysis; non-invasive BCIs.

Cross-Disciplines: Sustainable design, systems thinking and lifecycle optimisation; digital twins for infrastructure and Industry 5.0.

How to use this book

- Abstracts are grouped by subtheme. Each subtheme opens with a list of its papers and their presentation times.
- Each abstract shows its paper ID, session, date, time, room and mode (in person, online or poster).
- In the author line, the presenting author is underlined, the corresponding author is marked *, and the superscript numbers refer to the affiliations listed below the names.
- The Session Index lists all presentations in programme order, and the Author Index lists every author with page numbers.

Conference Committees

Host and Patrons

Role	Name	Office
Chief Host	Prof. Folasade T. Ogunsola, OON, FAS	Vice-Chancellor, University of Lagos
Host	Prof. Samson O. Adeosun	Dean, Faculty of Engineering, University of Lagos

Local Organizing Committee

Role	Name	Department / office
Chair	Prof. P. O. Oluseyi	Electrical and Electronics Engineering
Vice-Chair	Prof. L. O. Osoba	Metallurgical and Materials Engineering
Secretary	Mrs. A. A. Adewuyi	Faculty of Engineering
Alternate Secretary	Mr. M. O. Kassim	Chief Executive Officer, Dean's Office, Faculty of Engineering
Lead, Finance and Sponsorship	Dr. E. F. Ochulor	Metallurgical and Materials Engineering
Lead, Conference Platform and Webpage	Dr. J. A. Ogbemhe	Systems Engineering
Member	Dr. A. S. Alayande	Electrical and Electronics Engineering
Member	Dr. I. D. Adewale	Electrical and Electronics Engineering
Member	Dr. A. B. Ehinmowo	Petroleum and Gas Engineering
Member	Dr. S. C. Nwaneri	Biomedical Engineering
Member	Dr. M. Ogbonnaya	Mechanical Engineering
Member	Dr. S. A. Oke	Mechanical Engineering
Member	Dr. O. T. Olakoyejo	Mechanical Engineering
Member	Dr. F. Onoroh	Mechanical Engineering
Member	Dr. H. O. Onovo	Metallurgical and Materials Engineering
Member	Mr. T. J. Salami	Surveying and Geoinformatics

All members are of the Faculty of Engineering, University of Lagos.

Reviewers

The Committee thanks the following colleagues, who reviewed the papers submitted to FEIC 2026.

S/N	Name	Rank / designation	Department and institution
1	Dr. K. A. Abdulsalam	Senior Lecturer	Electrical and Electronics Engineering, University of Lagos
2	Dr. S. I. Adedokun	Associate Professor	Civil and Environmental Engineering, University of Lagos
3	Dr. O. A. Ajibade	Senior Lecturer	Metallurgical and Materials Engineering, University of Lagos
4	Mr. A. O. Alabi	Lecturer II	Surveying and Geoinformatics, University of Lagos
5	Dr. A. S. Alayande	Associate Professor	Electrical and Electronics Engineering, University of Lagos
6	Dr. E. G. Ayodele	Senior Lecturer	Surveying and Geoinformatics, University of Lagos
7	Dr. W. A. Ayoola	Associate Professor	Metallurgical and Materials Engineering, University of Lagos
8	Prof. O. T. Badejo	Professor	Surveying and Geoinformatics, University of Lagos

S/N	Name	Rank / designation	Department and institution
9	Miss O. C. Echeta	Lecturer II	Civil and Environmental Engineering, University of Lagos
10	Dr. O. A. Gbenle	Lecturer II	Biomedical Engineering, University of Lagos
11	Dr. O. A. George	Senior Lecturer	Systems Engineering, University of Lagos
12	Dr. I. A. Hamid-Mosaku	Senior Lecturer	Surveying and Geoinformatics, University of Lagos
13	Dr. S. B. Ipinsokan	Lecturer I	Petroleum and Gas Engineering, University of Lagos
14	Prof. E. O. Makinde	Professor	Surveying and Geoinformatics, University of Lagos
15	Dr. S. C. Nwaneri	Senior Lecturer	Biomedical Engineering, University of Lagos
16	Dr. E. F. Ochulor	Associate Professor	Metallurgical and Materials Engineering, University of Lagos
17	Prof. A. G. Odeshi	Professor and Associate Dean Academic	Mechanical Engineering, College of Engineering, University of Saskatchewan, Canada
18	Dr. J. A. Ogbemhe	Senior Lecturer	Systems Engineering, University of Lagos
19	Dr. S. A. Oke	Senior Lecturer	Mechanical Engineering, University of Lagos
20	Dr. F. O. Okewole	Lecturer I	Electrical and Electronics Engineering, University of Lagos
21	Dr. O. O. Olamigoke	Senior Lecturer	Petroleum and Gas Engineering, University of Lagos
22	Dr. F. Onoroh	Senior Lecturer	Mechanical Engineering, University of Lagos
23	Dr. H. O. Onovo	Senior Lecturer	Metallurgical and Materials Engineering, University of Lagos
24	Dr. O. Oribayo		Chemical Engineering, University of Lagos
25	Prof. L. O. Osoba	Professor	Metallurgical and Materials Engineering, University of Lagos
26	Mr. J. D. Pesaramilli, SMIEEE	Solutions Architect and Senior Data Engineer	Reveal Global, United States (industry)
27	Dr. W. A. Raheem	Senior Lecturer	Systems Engineering, University of Lagos

Committee members and reviewers who are authors of submitted papers took no part in the review of, or decisions on, their own papers.

Programme at a Glance

DAY 1 • WEDNESDAY 18 NOVEMBER 2026		
8:00 – 9:30 am	Arrival and registration of participants	[Registration desk]
9:30 – 11:00 am	OPENING CEREMONY Chief Host: Prof. Folasade T. Ogunsola, OON, FAS, Vice-Chancellor, University of Lagos Host: Prof. Samson O. Adeosun, Dean, Faculty of Engineering Welcome address: Prof. P. O. Oluseyi, Chair, Local Organizing Committee	Rahman Adisa Bello Hall, Faculty of Engineering
11:00 am – 12:00 pm	Keynote Address I: Prof. Akindele G. Odeshi (online)	Rahman Adisa Bello Hall, Faculty of Engineering
12:00 – 12:30 pm	Group photograph and tea break	[Foyer]
12:30 – 1:30 pm	Keynote Address II: Prof. Oludolapo Olanrewaju (online)	Rahman Adisa Bello Hall, Faculty of Engineering + online
1:30 – 2:30 pm	Lunch	
2:30 – 4:30 pm	Technical Session 1 — parallel sessions in Rooms A, B, C, D (IMS)	Rooms A–D (IMS)
4:30 pm	Close of Day 1	—

DAY 2 • THURSDAY 19 NOVEMBER 2026		
8:30 – 10:00 am	Registration continues	Registration desk
10:00 – 10:45 am	Plenary session: special address / lead paper / sponsor session	Rahman Adisa Bello Hall, Faculty of Engineering
10:45 – 11:45 am	Keynote Address III: Prof. Oluwatoyin Ashiru, OON (in person)	Rahman Adisa Bello Hall, Faculty of Engineering + online
11:45 am – 12:00 pm	Tea break	[Foyer]
12:00 – 1:30 pm	Technical Session 2 — parallel sessions in Rooms A, B, C, D (IMS)	Rooms A–D (IMS)
1:30 – 2:30 pm	Lunch	
2:30 – 4:00 pm	Technical Session 3 — parallel sessions in Rooms A, B, C, D (IMS)	Rooms A–D (IMS)
4:00 – 5:00 pm	Technical Session 4 — parallel sessions in Rooms A, B, C, D (IMS)	Rooms A–D (IMS)
5:00 pm	Conference dinner / social event	

DAY 3 • FRIDAY 20 NOVEMBER 2026		
10:00 – 11:00 am	Technical Session 5 — five online presentations (TS5A, TS5B) in Rooms A and B (IMS); make-up presentations for anyone who missed their slot	Rooms A and B (IMS) + online
11:00 – 11:30 am	Tea break	[Foyer]
11:30 am – 1:00 pm	[Panel discussion / workshop]: “From Laboratory to Lagos: Turning Engineering Research into Resilient Infrastructure and Enterprise for Nigeria’s Sustainable Development” Panellists: Prof. L. Osoba, Prof. T. A. Fashanu, & Prof. A. B. Ehinmowo	Rahman Adisa Bello Hall, Faculty of Engineering
1:00 – 2:00 pm	CLOSING CEREMONY — conference communiqué, best paper awards, vote of thanks (Prof. P. O. Oluseyi – LOC Chairman)	Rahman Adisa Bello Hall, Faculty of Engineering
2:00 pm	Lunch and departure	—

All times are West Africa Time (WAT, GMT+1). The full presentation schedule is in the Programme of Events.

Keynote Speakers



Prof. Akindele G. Odeshi, PhD, P.Eng., FEC

Professor & Associate Dean Academic, College of Engineering, University of Saskatchewan, Canada

Keynote: *Development and Characterization of Advanced Materials*

Keynote Address I • Wednesday 18 November 2026, 11:00 am – 12:00 pm • Online (4:00 – 5:00 am in Saskatchewan)

Prof. Akindele G. Odeshi, PhD, P.Eng., FEC is a Professor of Mechanical Engineering and Associate Dean Academic in the College of Engineering at the University of Saskatchewan, Canada. Prior to joining the University of Saskatchewan, he held Research Associate positions at Chemnitz University of Technology in Germany and the University of Manitoba, Canada.

His research focuses on the development and characterization of high-performance materials for extreme loading environments, including dynamic shock and impact conditions. His current work leverages advances in additive manufacturing to develop next-generation protective armor systems. He has also pioneered a cost-effective manufacturing approach for carbon/carbon composites and worked on corrosion mitigation for Saskatchewan's potash processing industry.

Professor Odeshi has published more than 100 peer-reviewed technical papers and has secured funding from government and industry partners.



Prof. Oludolapo Olanrewaju, PhD, P.Eng

Professor & Head, Industrial Engineering, and Interim Director, Institute of System Science, Durban University of Technology, South Africa

Keynote: *Energy, Efficiency and Intelligence: Innovative Integrated Modelling for Sustainable Development and Resilient Energy Infrastructure*

Keynote Address II • Wednesday 18 November 2026, 12:30 – 1:30 pm • Online (1:30 – 2:30 pm in South Africa)

Prof. Oludolapo Olanrewaju is an academic who loves to interact with his students by imparting knowledge to them. His primary responsibility is to enable students with the knowledge, skills necessary to allow them to expand their personal horizons and foster their abilities to be successful in their chosen career paths. He obtained his Doctorate in Industrial Engineering at the Tshwane University of Technology, Master of Science in Industrial and Production Engineering and Bachelor of Science (Honours) in Electrical and Electronics Engineering from the University of Ibadan.

He is a rated researcher with NRF. His research interests are not limited to Energy and Greenhouse gas analysis, Artificial Intelligence, Modelling and Lean applications. He has co-authored more than 150 publications which include journals, conference proceedings and book chapters. He is a recipient of awards both locally and internationally.



Prof. Oluwatoyin Ashiru, OON, FNSE, FAEng

Materials & Metallurgical Engineer; former Pro-Chancellor, Olabisi Onabanjo University, Nigeria

Keynote: *Engineering Nigeria's Future: Innovation, Resilient Infrastructure and the Courage to Build a Sustainable Nation*

Keynote Address III • Thursday 19 November 2026, 10:45 – 11:45 am • In person • Rahman Adisa Bello Hall, Faculty of Engineering

Prof. Oluwatoyin Ashiru, OON is the immediate past, Pro-Chancellor and Chairman of the Governing Council of Olabisi Onabanjo University. He is a renowned Materials and Metallurgical Engineer with more than 45 years' experience across Nigeria, the UK, the USA and the Middle East.

He earned a B.Sc. in Materials Science and Engineering from the University of Sussex, UK and a Ph.D. in Industrial Metallurgy from the University of Birmingham, UK. He began his career as a Lecturer at the Universities of Lagos and

Ibadan. Later, he held position as a Senior Research Fellow at the International Tin Research Institute, UK, and as a Professor at the King Fahd University of Petroleum and Minerals, Saudi Arabia.

He has consulted and contributed innovative technologies for leading oil, gas and petrochemical processing companies worldwide, including SABIC, Saudi Aramco, Shell, Qatar Oil, Chevron, Mobil and others.

Subtheme 1: Civil & Environmental Engineering

Smart, green and inclusive cities; climate-resilient infrastructure; AI for climate mitigation; renewable energy integration.

Paper	Title	Presenter	Session and time	Page
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CMT-08	Systems-Based Approach to Improving Urban Water Access in Low-Income Communities	Fuad Adegoke	TS3D, Thu 19 Nov, 2:50 pm, Room D (IMS)	16
E-37	Comparative Evaluation of Structural Boundaries on the Flexural Mechanics of Composite Laminates via a Robust Strain-Based Element	J. O. Edunro	TS3D, Thu 19 Nov, 3:10 pm, Room D (IMS)	17
CMT-49	Bridging the Gap: Professional Perceptions and Adoption of Mud Construction Techniques in Nigerian Urban Architecture	Emmanuel Gambo	TS3D, Thu 19 Nov, 3:30 pm, Room D (IMS)	18

CMT-07 | Civil & Environmental Engineering
Technical Session 3D • Thursday 19 November 2026 • 2:30 pm – 2:50 pm • Room D (IMS) • In person

CMT-07 Investigation of Concrete Tensile Strength with Partial Replacement of Cement with Bamboo Stem Ash (BSA) in Concrete Structures

Olusegun Afolabi*

University of Lagos, Nigeria

*Corresponding author: Olusegun Afolabi • Presenting author: Olusegun Afolabi

Abstract

The research is an investigation of concrete tensile strength with bamboo stem ash (BSA) partial replacement of cement, and involves evaluation of split tensile strength of BSA concrete under certain curing conditions for optimum replacement level of BSA. Cement paste is solely responsible for the formation of intermolecular bonds in solid concrete which directly affects tensile strength. The research procedure involves casting concrete cylindrical elements (150 x 300 mm long) using a mix proportion of 1:1.5:3 and a constant water cement ratio of 0.5. Concrete was partially replaced with bamboo stem ash at 5%, 7.5%, and 10% by weight of cement. Workability test was performed using slump test and two curing conditions were employed, ie, air and water, also splitting tensile test experiment were conducted at 3, 7, 14, 21, 28 and 42 days. Split tensile strength is calculated from observed failure load due to tension, and equivalent to loss of intermolecular force of attraction (ie, debonding) between concrete molecules. The observed results indicated that for air cured specimen, control concrete exhibited substantial increase in tensile strength between 3 and 14 days with maximum of 2.15 N/mm2 at 14 days, similarly 5% BSA concrete demonstrated considerable improvement during this period, with increase from 1.43 N/mm2 to 1.75 N/mm2 at 14 days, while replacement levels of 7.5% and 10% resulted in progressive reduction in tensile strength due to effect of BSA contribution to cementitious-paste matrix bond strength. Water cured specimen produces stable strength development throughout the curing period and at 3 days, 5% BSA concrete presented highest splitting tensile strength of 8.66N/mm2 at 14 days while the control concrete specimen strength equals 8.00 N/mm2 at 14 days. In conclusion, 5% BSA replacement level consistently produced highest tensile strength performance and beneficial effect at this replacement level effectively compensated for reduction in cement content

Keywords: *Concrete; Cement; BSA; tensile strength; intermolecular forces*

CMT-08 | Civil & Environmental Engineering
Technical Session 3D • Thursday 19 November 2026 • 2:50 pm – 3:10 pm • Room D (IMS) • In person

CMT-08 Systems-Based Approach to Improving Urban Water Access in Low-Income Communities

Fuad Adegoke*

Drips

*Corresponding author: Fuad Adegoke • Presenting author: Fuad Adegoke

Abstract

Urban water access in low-income communities is constrained by interconnected infrastructural, institutional, and socio-economic factors that infrastructure-only solutions fail to address. This study reframes urban water access as a complex, multi-stakeholder system rather than an isolated engineering problem. Using an integrated systems engineering methodology, including stakeholder mapping, root-cause analysis, causal loop and Ishikawa diagrams, and model-based systems engineering, we characterize the water access ecosystem and identify key bottlenecks: intermittent supply, hydraulic pressure imbalance, reliance on high-cost informal vendors, and non-revenue water losses. The proposed intervention architecture combines localized modular kiosks with storage, treatment, and smart metering; digital monitoring and AI-based anomaly detection; adaptive governance protocols linking utilities, communities, and NGOs; and formalized market integration with dynamic pricing. Evaluation metrics include service hours, WHO/UNICEF quality compliance, affordability, and system efficiency. Findings indicate that deficiencies cut across infrastructure, institutions, and community coordination, and that combining decentralized distribution with active feedback loops substantially improves resilience. This paper contributes a scalable, systems-based framework for improving water access equity and resilience in low-income urban communities, with proposed next steps including pilot deployment, stakeholder MoUs, and mixed-methods evaluation

Keywords: *systems engineering; resilient infrastructure; system-of-systems; non-revenue water*

E-37 | Civil & Environmental Engineering
Technical Session 3D • Thursday 19 November 2026 • 3:10 pm – 3:30 pm • Room D (IMS) • Online

E-37 Comparative Evaluation of Structural Boundaries on the Flexural Mechanics of Composite Laminates via a Robust Strain-Based Element

J. O. Edunro*, R. Abu

University of Ibadan

*Corresponding author: J. O. Edunro • Presenting author: J. O. Edunro (online)

Abstract

This paper evaluates the influence of boundary constraints on the flexural behavior of laminated composite plates using a 3-node triangular finite element framework. A common challenge in plate elements is maintaining accuracy across different boundary constraints without introducing artificial stiffness anomalies. By comparing Simply Supported (SS) and Clamped (CC) edge conditions under uniform transverse pressure, this study quantifies the structural variations caused by rotational constraints. Convergence calculations demonstrate that the element achieves a reliable second-order convergence rate for both boundary conditions. Furthermore, mesh distortion tests show error variations under 1.1%, verifying the element's suitability for complex structural geometries. Accurate stress evaluation is critical for composite design, but standard displacement-based finite elements often yield inaccurate stress predictions at structural boundaries. To address this, a 3-node Discrete Shear-Strain Triangular (DSCT) element is developed to recover layer-wise stresses directly from mid-surface curvatures using the transformed reduced stiffness properties of individual plies. The model applies a vectorized Tsai-Hill failure criterion to calculate structural failure indexes and evaluates edge effects using a Stress Concentration Factor (SCF). Quantitative assessments demonstrate that clamped boundaries exhibit significant stress concentrations compared to simply supported configurations, providing critical data for localized reinforcement strategies.

Keywords: *Laminated composite plates; Discrete Shear-Strain Triangular (DSCT) element; Boundary constraints; Stress Concentration Factor (SCF) and Tsai-Hill failure criterion*

CMT-49 | Civil & Environmental Engineering
Technical Session 3D • Thursday 19 November 2026 • 3:30 pm – 3:50 pm • Room D (IMS) • e-Poster (Poster e-Session)

CMT-49 Bridging the Gap: Professional Perceptions and Adoption of Mud Construction Techniques in Nigerian Urban Architecture

Emmanuel Gambo*, Olufunmilayo Adetoro

Covenant University

*Corresponding author: Emmanuel Gambo • Presenting author: Emmanuel Gambo (e-poster)

Abstract

Abstract to be supplied by the authors.

Subtheme 2: Mechanical & Aerospace Engineering

Robotics and human-centric automation; AI-driven manufacturing for circular and low-carbon industry; space systems.

Paper	Title	Presenter	Session and time	Page
E-75	Digital Audit Protocol for Plug and Cooling Load Analysis in a Building Envelope for Enhanced Energy Management Opportunities	E. O. B. Ogedengbe	TS1C, Wed 18 Nov, 4:10 pm, Room C (IMS)	20
CMT-45	Real-Time Embedded Shape Sensing and Closed-Loop Control of a Tendon-Driven Soft Continuum Robot Using a Two-Channel Flex-Sensor and IMU Architecture	Deborah Omolewo	TS3C, Thu 19 Nov, 3:10 pm, Room C (IMS)	21
CMT-48	Simulation and Optimization of a Car Suspension System for Enhanced Ride Comfort	Aghogho Edward	TS4C, Thu 19 Nov, 4:00 pm, Room C (IMS)	22
E-38	Ethanol as a Sustainable Fuel for Gasoline Direct-Injection Engines: Experimental Evaluation of Combustion, Efficiency and Emissions	Rafiu K. Olalere	TS4A, Thu 19 Nov, 4:20 pm, Room A (IMS)	23

E-75 | Mechanical & Aerospace Engineering
Technical Session 1C • Wednesday 18 November 2026 • 4:10 pm – 4:30 pm • Room C (IMS) • In person

E-75 Digital Audit Protocol for Plug and Cooling Load Analysis in a Building Envelope for Enhanced Energy Management Opportunities

O. G. Osuntuyi, E. O. B. Ogedengbe*, A. Omirin, M. Oyewole

Energhx Research Group, Department of Mechanical Engineering, Faculty of Engineering, University of Lagos

*Corresponding author: E. O. B. Ogedengbe • Presenting author: E. O. B. Ogedengbe

Abstract

A novel digital audit protocol for plug and cooling load analysis in residential and commercial building envelopes is designed and developed. A camera-based appliance recognition framework is proposed, built on a snapshot-based YOLO trainer that makes every model reproducible and on image and video detection endpoints that return recognised equipment for confirmation into the inventory, with the capture provenance of every item recorded (mAP@0.5 = 0.667 over nine classes). For the capturing of building information, metric room measurement from photographs is adopted, recovering perspective from each wall's own outline and scale from a reference object, which achieves 0.82% median area error against 12.2% for marker-homography extrapolation, with orientation from one compass bearing per room and a room-closure consistency check. Using an application programming interface, the developed protocol is integrated into the micro-service architecture of the EnerghxPLUS platform. By assessing and updating the platform's appliance database, a selected building envelope is simulated with appliances at the minimum energy performance standards (MEPS) and at different ENERGY STAR ratings available in the open energy market. For a specimen Lagos bungalow, the certified and best-available appliance sets reduce annual energy by 19.3% and 21.8% against the as-found inventory, while the peak cooling load, dominated by roof conduction, is almost unchanged. It is anticipated that the developed protocol will offer a reliable recommendation engine for efficient energy management opportunities (EMOs) to end-users.

CMT-45 | Mechanical & Aerospace Engineering
Technical Session 3C • Thursday 19 November 2026 • 3:10 pm – 3:30 pm • Room C (IMS) • In person

CMT-45 Real-Time Embedded Shape Sensing and Closed-Loop Control of a Tendon-Driven Soft Continuum Robot Using a Two-Channel Flex-Sensor and IMU Architecture

Deborah Omolewo*, John Ogbemhe

university of Lagos

*Corresponding author: Deborah Omolewo • Presenting author: Deborah Omolewo

Abstract

Soft continuum robots suit confined-space tasks such as minimally invasive surgery and infrastructure inspection, but their use is limited by the difficulty of measuring their shape without external cameras or trackers. This study built and evaluated a low-cost embedded sensing and control system for a tendon-driven soft continuum robot that pairs a resistive flex sensor, as a distributed curvature channel, with a tip-mounted inertial measurement unit (IMU) as an absolute orientation reference. A 300 mm single-segment arm with a 2.0 mm spring-steel backbone, 3D- printed spacer disks and a silicone sleeve was actuated by three stepper motors, and its shape was reconstructed from a fused bend angle with the constant-curvature model. The kinematic model and resolved-rate control law were first verified in a Python and MuJoCo simulation, in which 63 analytic checks passed, two errors in the reference model were corrected and closed-loop control reduced circle-tracking error by 94–96 % relative to open loop. Ten hardware experiments then followed. The arm bent repeatably (standard deviation 0.27°) but reached only 12–22 % of the bend predicted by the constant-curvature model. The IMU was precise (0.04° noise), whereas the flex sensor responded in one bending plane only. The estimation pipeline ran at 50 Hz with 2.2 ms of processing per cycle. Open-loop control gave a steady-state root-mean-square error of 7.23°, while feedback on the valid test step settled in 0.8 s with a steady-state error of −0.05°. The results support the architecture as a low-cost proof of concept for infrastructure-independent inspection.

Keywords: *soft continuum robot; embedded shape sensing; sensor fusion; constant curvature*

Also submitted as CMT-26; presented once.

CMT-48 | Mechanical & Aerospace Engineering
Technical Session 4C • Thursday 19 November 2026 • 4:00 pm – 4:20 pm • Room C (IMS) • In person

CMT-48 Simulation and Optimization of a Car Suspension System for Enhanced Ride Comfort

A. B. Edward[1*], Henry O. Omoregbee[2], Hussein O. Yekini-Ajayi[2], Sunday Ayoola Oke[2], Bayo Yemisi Ogunmola[3], Aghogho Edward[4*]

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[2]*Dept. of Mechanical Engineering, University of Lagos*
[3]*Dept. of Metallurgical and Materials Engineering, University of Lagos*
[4]*Federal University of Petroleum Resources, Effurun*

*Corresponding author: A. B. Edward, Aghogho Edward • Presenting author: Aghogho Edward

Abstract

This paper investigates the simulation and optimization of a car suspension system to enhance ride comfort, stability, and handling. A quarter-car and full-vehicle model were developed in SolidWorks and analyzed in ANSYS Workbench using static structural, modal, and transient analyses. Key parameters included spring stiffness (20,000 Nm), coefficient (1000 Ns/m), and tire stiffness (200,000 N/m). Under varying loads of 500 N, 1000 N, and 2000 N, stress values ranged from 99,988 Pa to over 2.0 MPa, while strain energy increased from 7.6×10^{-5} J to 3.0×10^{-2} J. Optimization using finite element analysis and genetic algorithms reduced deformation in critical components such as the front shock brace and upper arms, improving load distribution and minimizing stress concentrations. Results demonstrate that iterative refinement of design variables significantly enhances suspension durability and passenger ride comfort. The study highlights the importance of simulation-driven optimization in developing cost-effective, high-performance suspension systems adaptable to diverse road conditions.

Keywords: *Suspension System; Simulation; Optimization; Ride Comfort; Finite Element analysis; Structural Durability*

Also submitted as E-34; presented once.

E-38 | Mechanical & Aerospace Engineering
Technical Session 4A • Thursday 19 November 2026 • 4:20 pm – 4:40 pm • Room A (IMS) • In person

E-38 Ethanol as a Sustainable Fuel for Gasoline Direct-Injection Engines: Experimental Evaluation of Combustion, Efficiency and Emissions

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Abstract

The transition toward sustainable transportation requires alternative fuels capable of reducing petroleum dependence while maintaining satisfactory engine performance and controlling exhaust emissions. Ethanol, as a renewable and oxygenated fuel, offers significant potential for application in gasoline direct-injection (GDI) engines. This study experimentally evaluates the combustion, efficiency, and gaseous emission characteristics of absolute ethanol compared with commercial unleaded gasoline (ULG95) in a spray-guided GDI spark-ignition engine. Experiments were conducted at a constant engine speed of 1500 rpm over an indicated mean effective pressure (IMEP) range of 3.5–8.5 bar IMEP, under stoichiometric operating conditions. Combustion behaviour was assessed using peak cylinder pressure, coefficient of variation of IMEP (COVIMEP), combustion phasing, and combustion duration, while engine performance was evaluated through combustion and indicated thermal efficiencies and indicated specific fuel consumption. The gaseous emission of Carbon monoxide (CO), unburned hydrocarbons (HC), and nitrogen oxides (NO_x) were also investigated. Ethanol demonstrated improved combustion stability, faster combustion and higher thermal efficiency than ULG95, The Peak cylinder pressure of ethanol at the peak load of 8.5bar IMEP was recorded to be about 30% higher than that of gasoline because combustion of Ethanol is not mitigated by knock at high load. Reduced CO and HC emissions were recorded for the combustion of Ethanol compared to gasoline across the entire load range. These findings demonstrate the potential of ethanol to improve combustion and energy-conversion performance while reducing selected gaseous emissions, thereby supporting its application as a renewable fuel for more sustainable GDI transportation systems.

Keywords: *Ethanol*

Subtheme 3: Electrical & Computer Engineering

IoT and sensor networks; energy harvesting; wearables and nanotechnology; cyber-physical security; cloud, edge and distributed computing.

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CMT-13	Review and Future Directions for Distributed Energy Systems in Emerging Economies	Habeeb Olorukooba	TS1A, Wed 18 Nov, 3:10 pm, Room A (IMS)	27
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CMT-01 | Electrical & Computer Engineering
Technical Session 1A • Wednesday 18 November 2026 • 2:30 pm – 2:50 pm • Room A (IMS) • In person

CMT-01 AI-Enabled IoT Framework for Resilient Infrastructure Monitoring and Sustainable Transportation Systems

Joe Frank*

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Abstract

This paper presents an Artificial Intelligence (AI)-enabled Internet of Things (IoT) framework for monitoring critical transportation infrastructure and preventing operational losses in supply-chain networks. Developing economies face persistent challenges such as road deterioration, cargo theft, infrastructure failure, delayed deliveries, and poor real-time visibility. These issues undermine sustainable development and reduce infrastructure resilience. The proposed framework integrates GPS sensors, load sensors, environmental sensors, wireless communication modules, and machine-learning algorithms to provide continuous monitoring of transportation assets and infrastructure conditions. An Artificial Neural Network (ANN) model is employed to detect anomalies, predict risk events, and generate early-warning alerts. The system architecture consists of an edge-sensing layer, communication layer, cloud analytics layer, AI decision layer, and a web-based monitoring dashboard. Simulation results using synthetic logistics data demonstrate that the framework can identify abnormal events with high accuracy while improving operational visibility and response time. The study contributes an intelligent, scalable, and cost-effective approach for enhancing infrastructure resilience, reducing waste, improving transportation efficiency, and supporting the United Nations Sustainable Development Goals (SDGs), particularly SDG 9 (Industry, Innovation, and Infrastructure) and SDG 11 (Sustainable Cities and Communities).

Keywords: *Artificial Intelligence; Internet of Things; Resilient Infrastructure; Sustainable Development; Transportation Systems; Artificial Neural Network; Predictive Analytics*

CMT-05 | Electrical & Computer Engineering
Technical Session 1A • Wednesday 18 November 2026 • 2:50 pm – 3:10 pm • Room A (IMS) • In person

CMT-05 Adversarial Resilience and Privacy in AI-Driven Security Systems

Latifat Oderinu[1*], Kazeem Sodiq[2], Lateef Saliu[2], Bolanle Arowolo[2], Naseef Sanusi[2], Kabiru Olatidoye[2], Ibrahim Ogundero[2], Owolabi Shobowale[2]

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Abstract

Artificial intelligence(AI) has become embedded in cybersecurity operations in recent times, thereby making AI models themselves emerge as a distinct attack surface with implications for the resilience of industrial and economic systems that depend on them. This work synthesizes evidence on the adversarial and privacy dimensions of AI-driven security systems drawn from a systematic review of related literature published between 2018 and 2025. Evasion attacks are shown to degrade deep neural network detection accuracy by 30 to 60 percentage points, while data poisoning of as little as 0.5% of training samples can collapse targeted-class detection rates by more than 70 percentage points without measurably affecting aggregate accuracy metrics, rendering such attacks difficult to detect through standard validation. In response, the review examined federated learning as a privacy-preserving mechanism for collaborative, cross-organizational defense, quantifying a measurable privacy-utility trade-off in which differential privacy guarantees impose accuracy costs that grow sharply as privacy budgets tighten. The paper also addressed the persistent underinvestment in explainability: only a small minority of studies incorporate Explainable AI frameworks such as Shapley Additive Explanations (SHAP) and Local Interpretable Model-agnostic Explanation (LIME). Formal validation with Security Operations Centre analysts remains rare, despite evidence that opaque model outputs measurably erode analyst confidence. The paper concluded that adversarial robustness testing, privacy-aware federated architectures, and analyst-centered explainability must be co-designed rather than treated as independent add-ons, to enable sustainable and trustworthy AI adoption within resilient industrial security economies.

Keywords: *Adversarial machine learning; evasion attacks; data poisoning; federated learning*

CMT-13 | Electrical & Computer Engineering
Technical Session 1A • Wednesday 18 November 2026 • 3:10 pm – 3:30 pm • Room A (IMS) • In person

CMT-13 Review and Future Directions for Distributed Energy Systems in Emerging Economies

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Abstract

Developing countries believe that distributed energy systems (DES) can help them cross the electricity access gap and help them avoid problems that come with aging grids. While developed countries has progressed in areas such as predictive modeling and techno-economic optimization, that progress remains largely siloed. Most developing countries still primarily focuses on the siloed streams of modeling/predictive, engineering performance, narrow techno-economic, and socio-regulatory. This fragmentation creates barriers for policymakers and planners at sub-national levels who are trying to manage energy transition and achieve autonomy from centralized grids. This paper is a systematic literature review of the state of energy system modeling pertaining to DES and the integration of technical, economic, and regulatory barriers into energy system modeling. The results of our review demonstrate that modeling literature relies on overly simplistic generic cost objectives with respect to economic autonomy. Most modeling literature also regards autonomy as a static condition and largely ignores the consequences of autonomy on the system as a whole. The new research path we propose is Holistic Integrated Modelling (HIM). The HIM framework attempts to integrate engineering boundaries with economics (risk indicators), and societal and regulatory variables into a singular optimization framework, as opposed to fragmented analyses. For sub-national grid autonomy to be sustainable, this review suggests it should be regarded as an endogenous outcome, automatic from the intersection of synergized design and practical operational decisions.

Keywords: *Distributed Energy Systems (DES); Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA); Economic Model; Risk Adjusted Levelised Cost of Electricity (RA-LCOE); and Grid Autonomy*

CMT-14 | Electrical & Computer Engineering
Technical Session 1A • Wednesday 18 November 2026 • 3:30 pm – 3:50 pm • Room A (IMS) • In person

CMT-14 Stochastic Multi-Objective for Optimal Dispatch of Renewable-Rich Power Systems Under Uncertainty: A Review and Future Directions

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University of Lagos, Akoka, Lagos, Nigeria

*Corresponding author: Zainab Oba-Sulaiman • Presenting author: Zainab Oba-Sulaiman

Abstract

The increasing share of wind and solar photovoltaic generation in the power mix is transforming the operation of power systems. It however introduces significant uncertainty, as renewable resources depend on the weather and are therefore intermittent. This uncertainty impacts generation balance, power flows, transmission losses, congestion, and network security, whereas traditional single-objective dispatch techniques are not adequate to address multiple economic, technical, and environmental requirements. This paper reviews stochastic multi-objective optimization methods for optimal dispatch in renewable-rich power systems. It covers renewable uncertainty modeling, multi-objective dispatch functions, and the integration of stochastic and multi-objective optimization methods. A systematic review of relevant studies published between 2018 and 2026 was undertaken. The review shows a progressive shift from deterministic economic dispatch toward integrated stochastic multi-objective frameworks that incorporate generation cost, emissions, power losses, voltage performance, renewable utilization, congestion, and voltage stability. However, significant challenges remain in representing correlated renewable and load uncertainties, validating and reducing scenarios, managing computational complexity, and incorporating voltage-security requirements within large-scale stochastic AC optimal power flow. Future research should therefore emphasize correlation-aware uncertainty modeling, adaptive scenario reduction, scalable optimization, and practical decision-support mechanisms. These developments can improve the reliability, efficiency, flexibility, and sustainability of renewable-rich power systems, while facilitating higher renewable energy integration and progress toward sustainable energy development.

Keywords: *Sustainable Energy Integration; Renewable Uncertainty; Scenario Generation; Power*

CMT-15 | Electrical & Computer Engineering
Technical Session 1A • Wednesday 18 November 2026 • 3:50 pm – 4:10 pm • Room A (IMS) • In person

CMT-15 Emerging Trends in Hybrid Energy Storage for Low-Inertia Islanded Microgrids: Technologies, Applications and Research Directions

Kenneth Udeze[1*], **Sunday Adetona**[2], **Adeola Balogun**[2]

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*Corresponding author: Kenneth Udeze • Presenting author: Kenneth Udeze

Abstract

As inverter-based renewables take up a larger share of generation, islanded microgrids lose effective rotational inertia and become more exposed to intermittency, load changes, and sudden imbalances. Hybrid energy storage systems (HESS) address this by combining complementary technologies so that fast, high-power devices handle transients while high-energy devices cover longer deficits. The recent literature has expanded quickly across different combinations, architectures, and uses, which makes it difficult to see the overall direction. This paper reviews recent studies on HESS for low-inertia islanded microgrids and groups them by storage technology, system architecture, application, and research focus. It compares battery-supercapacitor, battery-flywheel, battery-hydrogen, and multi-technology configurations across frequency support, renewable smoothing, load management, voltage regulation, resilience, and multi-service operation. The review finds a clear shift from single-function storage toward coordinated hybrids that split duties across timescales and stack several services in one system. Recent work also tests a wider set of chemistries and configurations, pays more attention to resilience, handles uncertainty more explicitly in control and sizing, and weighs technical performance together with cost and environmental impact. Still, few results have been validated experimentally, metrics differ enough between studies to make direct comparison hard, head-to-head tests of different hybrids are rare, and coordination across timescales remains an open problem. The paper closes by mapping these gaps to concrete priorities for the next stage of HESS work in renewable-heavy islanded systems.

Keywords: *Hybrid energy storage systems; Low-inertia microgrids; Islanded microgrids; Renewable energy integration; Energy storage technologies; Multi-timescale energy management; Microgrid resilience*

E-76 | Electrical & Computer Engineering
Technical Session 1A • Wednesday 18 November 2026 • 4:10 pm – 4:30 pm • Room A (IMS) • In person

E-76 Voltage-Constrained Hosting Capacity Assessment of Decentralized Photovoltaic Injection in a Campus Distribution Network

Adedotun Daniel*, Peter Olabisi Oluseyi

Department of Electrical and Electronics Engineering, Faculty of Engineering, University of Lagos

*Corresponding author: Adedotun Daniel • Presenting author: Adedotun Daniel

Abstract

The integration of photovoltaic (PV) systems into radially operated distributed networks presents significant operational challenges, resulting in voltage limit violations from reverse power flow under high PV penetration and low demand. This paper assesses the voltage constrained hosting capacity (HC) of the medium-voltage (MV) network of a Nigerian university campus, with the low- voltage network excluded. The network, comprising 55 distribution transformers on 10 feeders fed by two parallel 33/11 kV transformers, was modelled in OpenDSS using building-type utilization, coincidence and power factor values. A rooftop PV potential of 8,436.15 kWp was injected simultaneously at 19 candidate transformers under peak sun and scaled from 10% to 500% of candidate capacity, for the daytime load and for minimum load cases with demand at 20%, 30% and 40% of the daytime value. Voltage compliance (0.94–1.06 pu for 400V and 0.95 – 1.05 for 11 kV), transformer and cable thermal limits and reverse power flow were checked. At daytime load the full rooftop potential is compliant, and the first constraint to bind is transformer thermal loading at 110% of the potential (9,279.8 kWp), before voltage at 170%. Under minimum load the HC falls to 94%, 91% and 80% of the potential, the 33/11 kV transformers export about 3.9 to 6.0 MW at full PV, and voltage becomes the first constraint at 30% and 20% demand. The tested cable length produced no measurable change in HC, while source voltage and PV power factor had an effect.

Keywords: *Voltage rise; Hosting Capacity; Minimum load; OpenDSS*

CMT-17 | Electrical & Computer Engineering
Technical Session 2A • Thursday 19 November 2026 • 12:00 pm – 12:20 pm • Room A (IMS) • In person

CMT-17 Optimal Adaptive Protection Coordination of a Campus Ring Network Using Standard Overcurrent Relays

Abdullahi Yusuf[1*], **Peter Olabisi Oluseyi**[2]

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Abstract

Modern distribution networks are shifting towards loop topologies for redundancy, but legacy protection coordination methods originally designed for radial systems are often inapplicable. The case in the University of Lagos 11 kV campus distribution network, which relies on thirteen standard relays, is that transitioning to an islanded microgrid reduces fault currents by approximately 45%. Consequently, fixed settings configured for grid-connected modes inevitably cause incorrect relay operation and severe coordination inversions under changing network topologies. While replacing existing infrastructure with directional relays is the conventional solution, this study formulates a cost-effective, software-based adaptive protection alternative to dynamically adjust Time Dial Settings. The network was modelled in the ETAP environment; for the purpose of analysing this network optimisation for the relays' operation, three metaheuristic algorithms (Grey Wolf Optimisation, Artificial Rabbits Optimisation, and Slime Mould Algorithm) were independently applied and comparatively evaluated to minimise the summed relay operating time while enforcing 29 strict coordination and selectivity constraints. Results indicate that baseline settings cause a -0.033 s margin inversion during grid-connected faults and fail entirely during tie-closed contingencies. In contrast, Grey Wolf Optimisation successfully restored a minimum 0.3 s coordination margin across all operating scenarios, achieving an optimal Grid-Connected Performance Index of 3.1634 s. By successfully resolving these topological miscoordination failures, this software-based optimisation delivers directional-like selectivity and serves as a reliable alternative to expensive hardware upgrades.

Keywords: *Adaptive Protection; Metaheuristic Algorithms; Microgrid; Overcurrent Relay; Protection Coordination*

CMT-18 | Electrical & Computer Engineering
Technical Session 2A • Thursday 19 November 2026 • 12:20 pm – 12:40 pm • Room A (IMS) • In person

CMT-18 Toward an Electrical Energy Harvesting of Low-Frequency Water Wave Energy

Ayodeji Odufuwa*

University of Lagos

*Corresponding author: Ayodeji Odufuwa • Presenting author: Ayodeji Odufuwa

Abstract

Low-amplitude waves generated by wind and boat traffic in sheltered water bodies such as lagoons represent an underexploited energy resource. Their low frequency and irregular motion make them poorly suited to conventional electromagnetic generators. This is an ongoing study which proposes a dual energy harvester combining a triboelectric nanogenerator (TENG) with a piezoelectric transducer to capture ambient wave motion in the lagoon. The TENG unit is being designed around a contact-separation configuration with polytetrafluoroethylene (PTFE) and aluminum electrode layers to target wave oscillations between 0.1 and 1.0 Hz, while a polyvinylidenefluoride (PVDF) piezoelectric cantilever is being incorporated to capture higher-frequency ripples and micro-impact vibrations induced by wave slap against the floating housing. Preliminary site characterization of the Lagos lagoon has recorded wave heights in the range of 0.1 – 0.5m and dominant periods of 4.38 – 4.42s, establishing the target operating window for prototype tuning. Bench-scale testing of individual TENG and piezoelectric elements is currently underway to determine the baseline voltage and power output before integration into a combined floating harvester unit. Subsequent work will involve field deployment along the lagoon shoreline to evaluate combined power output, energy conversion efficiency, and durability under continuous exposure to lagoon water and ambient humidity. The eventual goal is to power low-consumption devices like environmental sensors, lightings, nodes for temperature and turbidity monitoring. This research aims to establish a practical, low-cost pathway for self-powered environmental sensing in sheltered coastal and lagoon environments typical of urban West African waterways.

Keywords: *renewable energy; wave energy harvester; triboelectric nanogenerator; piezoelectric*

CMT-32 | Electrical & Computer Engineering
Technical Session 2A • Thursday 19 November 2026 • 12:40 pm – 1:00 pm • Room A (IMS) • In person

CMT-32 Roster or Reputation? Attributing Sybil Resistance to Mechanisms in Secure Clustered Wireless Sensor Networks

Saidi Adegoke*, Khadeejah Abdulsalam, Nureni Azeez

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*Corresponding author: Saidi Adegoke • Presenting author: Saidi Adegoke

Abstract

Secure clustering protocols for wireless sensor networks bundle several defensive mechanisms. In ledger-secured clustering protocols, three such mechanisms recur: a permissioned or registered authority set, a behavioural trust score, and a consensus quorum that must approve each ledger block. Most protocols combine two or three, yet report a single detection or admission rate rather than each mechanism's contribution. This is misleading, because the mechanisms observe different things and so cover structurally different adversary populations. This was formalised as a coverage relation between three mechanism classes and two adversary populations, from which three propositions were derived and then tested over 1,800 simulation runs at 20 seeds. First, a 2×2 factorial experiment, switching a registration roster and a behavioural veto on and off in every combination, separates the mechanisms cleanly. The roster keeps forged identities out of the cluster-head role entirely (0.0±0.0% at every attacker fraction and in every run), but does nothing against compromised hardware, which still holds 19.7±2.0% of cluster-head roles. The veto does the reverse: forged-identity capture stays at 10.1±0.9% against an undefended 10.1±1.0%. Second, making the veto five times faster to convict, or delaying the attacker's re-minting to four times the conviction time, leaves capture statistically flat ($p=0.425$; $p=0.752$). Third, deploying the roster alone raises compromised-hardware capture by 157× to 1028× ($p<10^{-11}$), a displacement effect that aggregate metrics conceal. Fourth, the two mechanisms interact super-additively on network half-life, buying 20.0% together against 1.1% and 3.1% apart ($p<10^{-5}$). A five-item reporting standard is proposed that makes mechanism attribution checkable by a reviewer.

Keywords: *Wireless sensor networks; Secure clustering protocols, Sybil attack; Trust and reputation*

CMT-43 | Electrical & Computer Engineering
Technical Session 2A • Thursday 19 November 2026 • 1:00 pm – 1:20 pm • Room A (IMS) • In person

CMT-43 Multiphase Flow Measuring: Using Multimodal Sensor, Machine Learning and Digital Twin Framework

Temilola I. Olatunji[1*], Ibukun Adewale[1], Adegboyega B. Ehinmowo[2], Olayinka Adewumi[3], Oyinkepreye D. Orodu[4], Aliyu M. Aliyu[5]

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*Corresponding author: Temilola I. Olatunji • Presenting author: Temilola I. Olatunji

Abstract

Accuracy in measurement of multiphase flow is essential for production allocation, reservoir management, and flow assurance. The conventional multiphase flow meters are costly and calibration intensive, while some depend on intrusive or radioactive measurement technologies. This research presents and evaluates a simulation on multimodal sensor multiphase flow metering technique that combines three different sensing modalities, acoustic sensing to determine flow velocity, optical sensing to determine phase fraction, and high-speed camera imaging to capture the flow regime images using feature-level fusion and machine learning, with an embedded digital twin for sensor-fault detection. The technique evaluated over 117 dataset of air–water operating points in a 50.8-mm horizontal flow loop spanning four flow regimes. Physics-based reconstruction resulted in a gas-holdup mean absolute percentage error (MAPE) of 1.7% and total-flow-rate MAPE of 5.2%, while water-flow-rate estimation resulted in a substantially higher MAPE of 43.2% and a systematic 43.1% overestimation associated with acoustic phase-slip in dispersed and slug flow. Feature-level fusion resulted in a better multimodal representation, with three principal components explaining 96.8% of the observed variance, and achieved error-free flow-regime classification on the held-out test set. With machine learning, the water-flow-rate reduced MAPE to 9.0% and removed the bias, while total-flow-rate, gas-flow-rate, and gas-holdup errors were reduced to 3.0%, 3.5%, and 1.0%, respectively. The digital twin of the sensor detected an injected acoustic-gain fault within approximately 0.5s. These results show the potential of multimodal sensing and feature level fusion to improve each measurement modality weaknesses while supporting sensor-health monitoring through a digital twin.

Keywords: *Multiphase flow metering; acoustic/optical sensing; sensor fusion; machine learning; digital twin*

CMT-44 | Electrical & Computer Engineering
Technical Session 3A • Thursday 19 November 2026 • 2:30 pm – 2:50 pm • Room A (IMS) • In person

CMT-44 Design and Construction of a Smart Color-Coded Battery Health Indicator

Micheal Makanjuola*

University of Lagos

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Abstract

The reliability of energy storage systems is often compromised by the lack of accurate and user-friendly battery health monitoring (BHM) tools. Traditional voltage-only monitoring is insufficient, as it fails to detect the critical increase in Equivalent Series Resistance (ESR), the primary indicator of battery degradation. This research proposes the design, construction, and validation of a smart, low-cost, color-coded battery health indicator specifically tailored for lithium-based batteries and tubular lead-acid batteries. The device will employ the DC load pulse method with a controlled pulse duration of 200 milliseconds to accurately measure ESR within the range of 10 mΩ to 2000 mΩ, and combine it with voltage data to determine the battery's State-of-Health (SoH) and capacity. The core innovation is the translation of complex electrical parameters into an intuitive, three-tier color-coded output (Green, Yellow, Red), enabling non-technical users to perform proactive maintenance. The device featured an integrated display to show battery capacity and optionally plot a graph of the battery's discharge characteristics over time. The project involved the development of a robust hardware circuit based on an ESP32 microcontroller and the creation of a calibrated algorithm validated against commercial battery analyzers. Validation testing was conducted on a minimum of 15 batteries across three degradation categories (new, moderately aged, and heavily degraded) for both lithium and tubular lead-acid chemistries, with an expected measurement accuracy within ±5% deviation compared to commercial reference instruments. The successful completion of this work provided a significant contribution to the field by democratizing advanced battery diagnostics, enhancing system reliability, and maximizing the lifespan of battery installations.

Keywords: *Li-ion; tubular lead-acid batteries; battery health monitoring (BHM); Equivalent Series Resistance (ESR); State-of-Health (SoH)*

CMT-46 | Electrical & Computer Engineering
Technical Session 3A • Thursday 19 November 2026 • 2:50 pm – 3:10 pm • Room A (IMS) • In person

CMT-46 One-Hour-Ahead Solar PV Power Forecasting Using Artificial Neural Network, Support Vector Regression and Random Forest: A Comparative Study on a Simulated 100-kW Grid-Connected System

Abiodun Odumosu*

Abraham Adesanya Polytechnic, Ijebu-Igbo

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Abstract

Accurate short-term forecasting of solar photovoltaic (PV) power is needed for reliable microgrid operation, battery scheduling and grid integration. This paper compares three machine learning models, namely an Artificial Neural Network (ANN), Support Vector Regression (SVR) and Random Forest (RF), for one-hour-ahead forecasting of the output of a simulated 100-kW grid-connected PV system. Sixty days of hourly data (1,440 samples) were generated from a simplified model driven by irradiance, ambient temperature, relative humidity and wind speed. Ten input features, including lagged power, lagged irradiance and cyclic time encodings, were used. The data were split chronologically into 70% training, 15% validation and 15% test subsets, and standardisation parameters were computed from the training data only. On the held-out test period, Random Forest was clearly the most accurate model, with an RMSE of about 3.2 kW, an MAE of about 2.0 kW and an R^2 of about 0.98. The ANN (RMSE ≈ 25 kW, R^2 ≈ 0.23) and SVR (RMSE ≈ 23 kW, R^2 ≈ 0.36), as configured, did not generalise to the test period. Their errors were dominated by overshoot at peak hours (ANN) and non-zero night-time output (SVR). The results show that, for small tabular PV datasets, a lightly tuned ensemble of trees can be considerably more robust than lightly tuned neural and kernel models. The limitations of a synthetic dataset and the missing baselines are discussed, and directions for validation on measured data are given

Keywords: *solar photovoltaic; power forecasting; machine learning; artificial neural network; support vector regression; random forest; short-term forecastin*

E-39 | Electrical & Computer Engineering
Technical Session 3A • Thursday 19 November 2026 • 3:10 pm – 3:30 pm • Room A (IMS) • In person

E-39 Quasi Moment Method Analysis of Greenhouse Gases

R. M. Balocun-Adeleye, F. O. Okewole*, J. Ogbemhe, O. A. George

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*Corresponding author: F. O. Okewole • Presenting author: R. M. Balocun-Adeleye

Abstract

This paper develops a theoretical model to study the greenhouse features and evaluate its state variables. The Quasi Moment Method (QMM) is employed for the analysis and design of the greenhouse. In this method, the unknown coefficients are determined, and then, the predicted results are obtained through the formulated expression. Based on the analytical results, MATLAB codes are developed for computational results. These results are compared with experimental and simulation results for validation's sake. The results obtained are consistent with the existing data available in the literature. Also, in terms of Mean Squared Error (MSE), the numerical values of least square method, and the developed model are 60.39, and 41.37, respectively. These results showed that the model outperformed the published data of the existing method.

Keywords: *Greenhouse; quasi-moment method; Greenhouse parameters; mean squatted error; Climate Control*

CMT-06 | Electrical & Computer Engineering
Technical Session 3A • Thursday 19 November 2026 • 3:30 pm – 3:50 pm • Room A (IMS) • Online

CMT-06 Energy Harvesting and Autonomous Systems: A Realistic Pathway Towards Sustainable Development and Resilient Infrastructure in Nigeria

Ruth Asi*

University of Calabar

*Corresponding author: Ruth Asi • Presenting author: Ruth Asi (online)

Abstract

Nigeria's power sector is defined by a persistent gap between installed generation capacity and actual electricity delivery. Installed capacity stands at approximately 13,000 MW, yet peak grid delivery in 2025 rarely exceeded 5,500 MW, with average daily supply closer to 4,000 MW. Fossil fuels provide about 80% of the country's primary energy, while renewables contribute less than 15%, despite abundant solar resources. This paper proposes solar photovoltaic energy harvesting integrated with autonomous systems as a realistic pathway toward closing this generation gap and building genuinely resilient infrastructure in Nigeria. Solar harvesting is prioritized over microwatt- and milliwatt-scale modalities, which are unsuited to a multi-gigawatt national supply deficit. Adopting a conceptual framework that integrates technology assessment with policy analysis, the study evaluates the potential of distributed, grid-scale solar photovoltaic harvesting, deployed and optimized through autonomous sensing, decision-making, and control systems, to expand bulk sustainable energy supply with minimal human intervention. The framework aligns with Nigeria's energy reforms, including the 2026 Nigerian Electricity Regulatory Commission (NERC) Mini-Grid Regulations, Distributed Access through Renewable Energy Scale-up (DARES) programme, and the National Integrated Electricity Policy and Strategic Implementation Plan (NIEP-SIP). The paper develops a six-month forecast (July–December 2026) outlining a phased pathway for pilot deployment, capacity expansion, policy alignment, and infrastructure resilience. It concludes that technological innovation alone is insufficient; sustainable outcomes require effective governance, local technical capacity, community ownership, affordable technology, improved maintenance practices, and institutional consistency, offering a practical, replicable model for advancing bulk-scale sustainable energy access and infrastructure resilience across Nigeria.

Keywords: *energy harvesting; autonomous systems; sustainable development; resilient infrastructure; mini-grids; Nigeria*

CMT-11 | Electrical & Computer Engineering
Technical Session 5A • Friday 20 November 2026 • 10:00 am – 10:20 am • Room A (IMS) • Online

CMT-11 Artificial Intelligence for Optimising Software Quality Metrics Assessment: A Framework for Reliable and Resilient Engineering Systems

Favour Atolagbe*

Lead City University

*Corresponding author: Favour Atolagbe • Presenting author: Favour Atolagbe (online)

Abstract

The growing dependence of engineering systems on software has made software quality an important factor in system reliability and resilience. Software quality metrics such as cyclomatic complexity, coupling, cohesion, defect density, and test coverage provide useful evidence about the condition of a software system, but assessing and interpreting these metrics across large and continuously changing codebases can be difficult. This paper explores how artificial intelligence can be used to improve the assessment of software quality metrics and proposes a conceptual framework for its application in reliable and resilient engineering systems. The study draws on recent literature covering machine learning for defect and maintainability prediction, large language models for code review, and the emerging challenges associated with AI generated and AI assessed software. Based on these findings, the proposed AI Augmented Software Quality Metrics Assessment (AI SQMA) framework brings together automated metric extraction, AI based analysis, large language model assisted review, and human validation. The framework is designed to help developers identify potential quality problems earlier, interpret software quality indicators more effectively, and support decisions that may improve software reliability and maintainability. The paper argues that AI should complement, rather than replace, established software engineering practices and professional judgement. The framework provides a basis for future empirical studies of AI assisted quality assessment in software dependent engineering systems. Keywords: Artificial intelligence; Software quality metrics; Software quality assessment; Machine learning; Large language models; Resilient engineering systems

Keywords: *Artificial intelligence; Software quality metrics; Software quality assessment; Machine learning; Large language models; Resilient engineering systems*

CMT-38 | Electrical & Computer Engineering
Technical Session 5B • Friday 20 November 2026 • 10:00 am – 10:20 am • Room B (IMS) • Online

CMT-38 Design and Hardware Evaluation of a Software-Defined Radio-Based Emergency Vehicle Pre-Emption System

Abiodun Gbenga-Ilori*, **Joseph Eze**

University of Lagos

*Corresponding author: Abiodun Gbenga-Ilori • Presenting author: Joseph Eze (online)

Abstract

Emergency response times in Nigerian urban areas are significantly affected by traffic congestion, causing delays for emergency vehicles. Conventional Emergency Vehicle Pre-emption (EVP) systems can require substantial infrastructure, reliable cellular connectivity, and high installation costs. This paper presents a decentralised, low-cost Software-Defined Radio (SDR)-based EVP system for emergency vehicles, with emphasis on ambulances. The system comprises an SDR transmitter installed on the ambulance, transmitting a GFSK-modulated emergency beacon at 433 MHz, and an SDR receiver at the intersection that detects the beacon and initiates traffic-light pre-emption through a USB serial interface to an Arduino microcontroller. The transmitter and receiver signal chains were implemented using GNU Radio Companion, with hardware-in-the-loop testing conducted primarily using two Xilinx Zynq XC7Z020 SDR units, with Nuand BladeRF 2.0 used for comparison. A two-lane traffic-light finite-state machine incorporated pre-emption entry, post-clearance operation, and watchdog-based timeout mechanisms. Pre-emption was successfully demonstrated at all tested separations from 1 to 10 m, with a 37.6 dB signal margin at 10 m. Access-code selectivity testing recorded no detections when the configured code was mismatched, despite the carrier remaining visible. However, intermittent receiver termination caused by invalid packet lengths, particularly at greater distances and under obstruction, limited extended-range testing. Transmitter buffer underruns observed with longer packet intervals were resolved by reducing the beacon interval to 50 ms. The prototype demonstrates the feasibility of a low-cost, infrastructure-independent EVP approach for resource-constrained urban environments.

Keywords: *Software-defined radio; emergency vehicle pre-emption; traffic signal control; GFSK; RF beacon*

CMT-22 | Electrical & Computer Engineering
Technical Session 5A • Friday 20 November 2026 • 10:20 am – 10:40 am • Room A (IMS) • Online

CMT-22 Performance Trade-Off Analysis of Energy-Aware Strategies in Data Center Networks: UNILAG Backbone Network Core as a Case Study

Joshua Olusola*

Backend Developer

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Abstract

In networking, the underlying infrastructure consumes energy continuously, yet network devices are non-energy-proportional. This means that they draw their power by simply being powered on, regardless of the traffic load. Due to this, there exists an opportunity to reduce energy consumption by consolidating the redundant devices found in the network topology during periods of low demand. Studies have been made extensively on energy-aware strategies such as device consolidation on idealized data center topologies, but their application to real, heterogenous campus backbone networks where redundancy is placed at concentrated levels rather than uniform across the topology is largely unexamined. This study investigates the performance trade-off of energy-aware strategies applied to the University of Lagos backbone network as a case study. The model of the backbone was made using ns-3, a discrete-event simulator for network simulation, driven with a traffic-driven model in which the utilization is measured based on routed traffic rather than assumed. This study utilizes four strategies; they include baseline, consolidation, flow scheduling, and hybrid, evaluated across two traffic patterns (uniform, hotspot), three load levels (0.2, 0.5, 0.8), and five repetitions for each, giving a total of 120 simulation runs. Energy consumption and performance metrics were analyzed through a Pareto frontier and regression analysis. The results of this study reveal that consolidation in the backbone topology is done by genuinely looking for a redundant pair that could be used in place when demand is low and achieves a 15.3% reduction in infrastructure power across every load level at a low packet-loss penalty of about 0.1 percentage points, preserving the network connection. The energy-performance trade-off is highly linear (r^2 = 0.967), revealing that every 1% saving in energy shows a 0.24 percentage point of additional packet loss.

Keywords: *Energy-performance tradeoff; Network device consolidation; Ns-3 simulation; Campus Backbone; Energy-aware networking*

CMT-34 | Electrical & Computer Engineering
Technical Session 5A • Friday 20 November 2026 • 10:40 am – 11:00 am • Room A (IMS) • Online

CMT-34 Mathematical Frameworks for Passive Filter Design for Harmonic Mitigation in Power Supply Networks: A Review (Full Length)

Gerard Obiora*, Akintunde Alayande, Osita Omeje, Nurudeen Shokoya

University of Lagos

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Abstract

The rapid growth of non-linear loads and inverter-based Renewable Energy Sources (RESs) has worsened Power Quality (PQ) issues in industrial, commercial, utility, and RE networks. Passive harmonic filters remain the most economical and reliable mitigation option. However, designing these filters has become more difficult due to complex system interactions and component variations. In this review study, the governing equations for three commonly used passive filters: Single Tuned Passive Filter (STPF), Double Tuned Passive Filter (DTPF) and C-type High Pass (HP) Filter, are presented. Based on these, three shunt linked Passive Filter Bank (PFB) configurations are suggested as practical solutions for improved broadband harmonic mitigation. The first and second configurations each combines two STPFs with: a C-type HP filter, and then a 2nd Order HP filter respectively. The third uses a DTPF and a C-type HP filter to suppress multi- order harmonics. This study will thus help guide future researchers in employing the right design equations for determining the individual component parameters of these passive filters for improved PQ.

Keywords: *C-type high pass filter; single tuned passive filter; double tuned passive filter*

Also submitted as CMT-12; presented once.

Subtheme 4: Chemical & Materials Engineering

Green process technology and sustainable materials for African industrial transformation.

Paper	Title	Presenter	Session and time	Page
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CMT-03	Synthesis of Graphene Oxide from Coconut Shell Particles Using the Improved Tour's Method	Oluwaseyi Ajibade	TS4D, Thu 19 Nov, 4:00 pm, Room D (IMS)	45
CMT-35	Fabrication and Characterisation of Polyester-Fiberglass Manhole	Henry Mgbemere	TS4D, Thu 19 Nov, 4:20 pm, Room D (IMS)	46
CMT-02	The Effect of Post-Processing on the Mechanical Properties of Additively Manufactured Polymeric Materials	Olayemi Coker	TS4B, Thu 19 Nov, 4:40 pm, Room B (IMS)	47
E-68	Effect of Heat-Treatment on the Hydrogen Embrittlement Response of Electroless Ni–P–Al_2O_3 Nanocomposite-Coated Steel	J. B. Agboola	TS4D, Thu 19 Nov, 4:40 pm, Room D (IMS)	48

E-74 | Chemical & Materials Engineering
Technical Session 3B • Thursday 19 November 2026 • 3:30 pm – 3:50 pm • Room B (IMS) • In person

E-74 Mechanical Property, Functional Group and Pore Size Distribution Analyses of Electrospun Gelatin Cellulose Acetate for Suitability in Wound Dressing Applications

E. F. Ochulor*, O. A. Lawal, H. E. Onovo, O. F. Ogbonmwan

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*Corresponding author: E. F. Ochulor • Presenting author: E. F. Ochulor

Abstract

Electrospun nanofibers are attractive for wound dressing applications due to their high surface area, porosity and structural similarity to the extracellular matrix. Pure gelatin nanofibers, suffer from poor mechanical strength and limited aqueous stability. In this study, gelatin was reinforced using varying concentrations of cellulose acetate: 1, 3 and 5 wt.% CA in order to overcome these challenges. The resulting gelatin–cellulose acetate (CA) solutions were then electrospun to produce gelatin–cellulose acetate nanofibers. The nanofibers mats were characterized via tensile test for mechanical strength; Fourier transform infrared spectroscopy (FTIR) for functional groups present and Scanning electron microscopy (SEM) combined with ImageJ analysis for pore size analysis. FTIR confirmed intermolecular hydrogen bonding between two polymers. Scanning electron microscopy with ImageJ showed that the addition of cellulose acetate reduced the pore sizes from 9.61, 9.57, 9.47 and 8.90 for 0, 1, 3 and 5 wt. % of CA. Tensile test revealed that tensile strength and elastic modulus increased with increase in addition of CA, with Gelatin 5wt. % CA recording the highest values of 0.668 MPa and 14.63 MPa respectively. The elongation of break (EAB) and energy at break did not show any particular trend with increase in CA concentration. Mechanical testing revealed that the best balance of tensile strength (0.478 MPa), elongation at break (24.970%) and energy at break (0.0521 J) was achieved at Gelatin 3 wt.% CA. The results showed that the functional group interactions, pore characteristics and mechanical strength of the obtained composite were significantly improved at 3 wt.% CA.

Keywords: *Gelatin; cellulose acetate; electrospun; nanofibers; tensile strength; wound dressing*

CMT-03 | Chemical & Materials Engineering
Technical Session 4D • Thursday 19 November 2026 • 4:00 pm – 4:20 pm • Room D (IMS) • In person

CMT-03 Synthesis of Graphene Oxide from Coconut Shell Particles Using the Improved Tour's Method

Oluwaseyi Ajibade*, Akinsola Akintola, Temidayo Adedayo, Olajuwon Osifowora

University of Lagos

*Corresponding author: Oluwaseyi Ajibade • Presenting author: Oluwaseyi Ajibade

Abstract

The challenges associated with conventional graphite-based Graphene Oxide (GO) such as reduced electrical conductivity, quality inconsistency, complicated and potentially harmful production process, restrained mechanical integrity demands less complex and safer viable alternatives. This investigation delves into the synthesis of Graphene Oxide from coconut shells, a renewable biomaterial. The first phase was the preparation of the Activated Coconut Shell Graphite (ACSG) pulverized coconut shell particles. This was followed by oxidizing using the Improved Tour method, which is a safer method than classical methods. Successful conversion was demonstrated in characterization of the final product, with the FTIR and XRD results. This was also complimented by the SEM images which depicted the desired wrinkled sheet-like texture, while the EDX showed high ratio of Carbon and Oxygen (C: 58, O: 36). The Raman spectroscopy showed that the D and G bands exhibited defect-based breathing modes of sp carbon rings and plane stretching of sp2 carbon rings, at ~1342 cm-1, and ~1571 cm-1 respectively. It was observed that both maxima looked wide and intense which characterizes the formation of Graphene Oxide. These findings show the potential of coconut shells as a sustainable feedstock with the Improved Tour method confirmed as an efficient route Graphene Oxide production.

Keywords: *Graphene oxide; Coconut shells; Biomaterial; Material characterization*

CMT-35 | Chemical & Materials Engineering
Technical Session 4D • Thursday 19 November 2026 • 4:20 pm – 4:40 pm • Room D (IMS) • In person

CMT-35 Fabrication and Characterisation of Polyester-Fiberglass Manhole

Henry Mgbemere*, Eugenia Obidiegwu, Lawrence Osoba, Feranmi Obadipe

University of Lagos

*Corresponding author: Henry Mgbemere • Presenting author: Henry Mgbemere

Abstract

Cast iron-based manhole covers are durable but are frequently stolen by scavengers, prompting the need for research on possible alternatives. This research investigated the fabrication and performance evaluation of a fibreglass-reinforced manhole cover as a possible alternative. Fibreglass-reinforced polyester manhole covers were produced in three configurations using chopped strand and woven roven fibres. Compressive and flexural strength tests, hardness and microstructural analysis were used to characterise the samples. The results showed that the configuration with alternating layers of woven roven and chopped strand recorded the best properties. The compressive and flexural strength results gave 55-60 MPa and 60-70 MPa, respectively, which exceeded cast iron in flexural capacity but were weaker in compression. The hardness results showed that the three configurations gave Vickers hardness values between 20 and 25 VHN, much lower than that of cast iron. The microstructure of the three sample configurations revealed differences in fibre-matrix bonding and elemental composition. The polyester-fibreglass manhole cover demonstrated reduced weight capability, making it a promising alternative for low and medium load-bearing applications.

Keywords: *Manhole cover; Fibre-reinforced composite; polyester; glass fibre*

CMT-02 | Chemical & Materials Engineering
Technical Session 4B • Thursday 19 November 2026 • 4:40 pm – 5:00 pm • Room B (IMS) • Poster (Foyer; to be confirmed)

CMT-02 The Effect of Post-Processing on the Mechanical Properties of Additively Manufactured Polymeric Materials

Atinuke Oladoye, Olayemi Coker*, Lukmon Oladosu, Rasheed Mohammed, Lawrence Osoba

University of Lagos

*Corresponding author: Olayemi Coker • Presenting author: Olayemi Coker (poster)

Abstract

In this study, the effect of post-processing on the mechanical (tensile and microhardness) properties of additive-manufactured polymeric materials, ABS and PLA, was investigated with a view to understanding its potential influence on functional performance. Salt annealing (using fine soda ash medium) of polylactic acid (PLA) and acrylonitrile butadiene styrene (ABS) AM parts produced using fused deposition modelling (FDM) was carried out to address a major limitation (dimensional warping and distortion) known with conventional annealing. PLA and ABS specimens printed in both X and Z build orientations using three-layer heights (0.12 mm, 0.20 mm, and 0.28 mm) were heat-treated in a compacted salt bed at carefully determined optimised temperatures that relieve residual stresses, improve interlayer bonding, and enhance material densification. The effectiveness of the treatment was assessed by comparing the tensile and microhardness properties, including fractographic behaviour of the annealed specimens compared to the as-built samples. Overall, the study aims to demonstrate how salt annealing alters the structure–property relationship of additively manufactured polymers, offering a simple, cost-effective post-processing technique to improve mechanical performance, remove limitations of anisotropy, and narrow the gap between rapid prototyping and functional manufacturing.

Keywords: *Fused Deposition Modelling (FDM); Polylactic Acid (PLA); Acrylonitrile Butadiene Styrene (ABS); post-processing; salt annealing; anisotropy; tensile strength; microhardness; fractography*

E-68 | Chemical & Materials Engineering
Technical Session 4D • Thursday 19 November 2026 • 4:40 pm – 5:00 pm • Room D (IMS) • In person

E-68 Effect of Heat-Treatment on the Hydrogen Embrittlement Response of Electroless Ni–P–Al_2O_3 Nanocomposite-Coated Steel

J. B. Agboola*, G. A. Tijani-Bello, A. M. Oladoye

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*Corresponding author: J. B. Agboola • Presenting author: J. B. Agboola

Abstract

Hydrogen-induced degradation remains a concern for low-carbon steel in hydrogen-containing service. This study examined the effects of electroless Ni–P and Ni–P–Al_2O_3 coatings and post-deposition heat treatment on the mechanical response of low-carbon steel after exposure to ammonium thiocyanate (NH_4SCN). The specimens were exposed to 20 wt.% NH_4SCN at 50 °C for 48 h before slow strain rate tensile testing. Characterization and performance evaluation involved Vickers microhardness testing, tensile testing before and after exposure, immersion mass-change assessment, scanning electron microscopy (SEM), energy-dispersive X-ray spectroscopy (EDS), and X-ray diffraction (XRD). The composite-coated specimen heat-treated at 300 °C for 1 h (S5) had the highest unexposed ultimate tensile strength (507.75 MPa), a strain-based embrittlement index of 1.26%, and a reported immersion mass-loss rate of 1.64 mg cm^{-2} day^{-1}, approximately half that of the uncoated steel. The 500 °C specimen (S6) had the highest measured hardness (241.96 HV0.1), but also the highest reported mass-loss rate (4.93 mg cm^{-2} day^{-1}). The results suggest that heat treatment at 300 °C may offer a favourable balance of tensile strength, mass-loss response, and limited measured ductility reduction after NH_4SCN exposure. Because tensile testing lacked independent replication, exposed S3 data were unavailable, and hydrogen permeation was not measured, the findings are preliminary and do not establish a hydrogen-barrier mechanism.

Keywords: *electroless coating; Ni–P–Al_2O_3; heat treatment; hydrogen embrittlement; NH_4SCN exposure*

Subtheme 5: Industrial & Systems Engineering

Circular economy and systems thinking; climate action; sustainable AI for resilient economies.

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CMT-16 | Industrial & Systems Engineering
Technical Session 1C • Wednesday 18 November 2026 • 2:30 pm – 2:50 pm • Room C (IMS) • In person

CMT-16 The Effects of Laser Radiation Interface with Insect Pest Tissues: A Theoretical Framework Supported by MATLAB Simulations

Oluwaseyi Bolarinwa*

University of Lagos

*Corresponding author: Oluwaseyi Bolarinwa • Presenting author: Oluwaseyi Bolarinwa

Abstract

This study explores the theoretical framework of laser-induced effects on household insect tissues, specifically focusing on bed bugs (Cimex lectularius), cockroaches (Blattella germanica), and ticks (Ixodes ricinus). Utilizing MATLAB simulations, the research analyzes heat distribution within insect tissues, assesses the sensitivity of thermal responses to varying laser parameters, and evaluates the potential for thermal damage. The findings suggest that laser radiations can effectively induce targeted thermal damage in insect tissues, presenting a promising non-chemical insect pest control strategy. This framework emphasizes the necessity for empirical validation of simulation predictions and the optimization of treatment protocols for practical pest management applications.

Keywords: *Chemical Pesticides; Eco-Friendly Smart Laser Control Systems; Cost Savings; Environmental Impact; Household Insect Pest Management; Pest Elimination; Public Health; Sustainability; User Acceptance*

CMT-20 | Industrial & Systems Engineering
Technical Session 1C • Wednesday 18 November 2026 • 2:50 pm – 3:10 pm • Room C (IMS) • In person

CMT-20 Autonomous Field Robot for Real-Time Pest Detection and Localised Intervention Using Multispectral Imaging and AI

John Ogbemhe, Ahmad Hamid-Mosaku*

University of Lagos

*Corresponding author: Ahmad Hamid-Mosaku • Presenting author: Ahmad Hamid-Mosaku

Abstract

Pest infestations destroy between 20 and 40 per cent of crop yields across -Saharan Africa every growing season. The standard response, broadcast chemical spraying on a calendar schedule wastes 60 to 90 per cent of the pesticide on vegetation that needs no treatment. That wasted product does not simply represent lost money. It degrades soil biology contaminates surface water and accelerates resistance development in the pest populations it was meant to control. This paper presents a cost autonomous ground robot designed to address that specific inefficiency. The robot navigates crop rows without steering identifies pest infestation and crop damage at the plant level using a YOLOv11 nano deep learning model running at 2.9 frames per second on a Raspberry Pi 4 and sprays only at confirmed detection sites through a servo-aimed nozzle. A dual-band RGB and infrared sensing pipeline enables computation of the Normalised Difference Vegetation Index for detecting physiological stress before visible symptoms appear while Contrast Limited Adaptive Histogram Equalisation addresses the illumination variability of outdoor field conditions. The detection model outputs one of three classes, pest, crop damage or healthy tissue and dispatches actuation commands to an ESP32 microcontroller running FreeRTOS firmware, which fires a submersible spray pump within 561 milliseconds of image capture. Five independent safety layers guarantee safe operation under hardware or software fault conditions. Cross-track row-following error stays below 50 millimetres at 0.34 metres per second. The complete hardware bill of materials totals 266 United States dollars demonstrating that plant-level autonomous pest management is technically achievable on platforms to smallholder farmers, across West Africa.

Keywords: *precision agriculture; edge inference; deep learning; embedded robotics; NDVI*

CMT-25 | Industrial & Systems Engineering
Technical Session 1C • Wednesday 18 November 2026 • 3:10 pm – 3:30 pm • Room C (IMS) • In person

CMT-25 Multi-Objective Mixed-Integer Programming and NSGA-II Optimization for Assembly Line Balancing to Improve Throughput and Workforce Efficiency

Toyosi Jogunola, John Ogbemhe*

University of Lagos

*Corresponding author: John Ogbemhe • Presenting author: John Ogbemhe

Abstract

The Assembly Line Balancing Problem (ALBP) is an NP-hard problem, and most multi-objective solutions do not combine exact and metaheuristic methods or consider workforce efficiency as a main optimisation criterion. This work develops a hybrid Mixed-Integer Programming (MIP)–Non-dominated Sorting Genetic Algorithm II (NSGA-II) approach for multi-objective assembly line balancing, optimising cycle time and a Workload Balance Index (WBI) to enhance throughput and workforce efficiency. A MIP model encoding precedence, cycle-time, and workload-balance constraints was embedded as a periodic local-search step within NSGA-II and tested on two Scholl-library benchmark instances using 30 seeds for 100 and 500 NSGA-II generations. For the small Bowman8 instance (n=8), all 30 hybrid runs reached the known optimum (cycle time 17.0, WBI 8.0) and required about half the wall-clock time of plain NSGA-II (39.9 versus 84.7 seconds mean per seed). For the medium Roszieg instance (n=25), the hybrid achieved a slightly larger mean hypervolume, although the difference was not statistically significant (p=0.577, paired Wilcoxon signed-rank test). An additional construction-feasibility defect was identified and corrected, showing that the construction heuristic is incorrect for near-zero-slack instances with less than 1% slack. Results demonstrate that the hybrid framework can maintain solution quality while reducing computational time, clarifying when hybrid exact-metaheuristic methods provide practical value for resilient human-centric manufacturing systems.

Keywords: *combinatorial problems; production systems; genetic algorithms; Pareto front; hypervolume*

CMT-27 | Industrial & Systems Engineering
Technical Session 1C • Wednesday 18 November 2026 • 3:30 pm – 3:50 pm • Room C (IMS) • Online

CMT-27 A Systems-Thinking Framework for Circular Economy-Enabled Sustainable AI in Climate-Resilient African Economies

Fawaz Azeez*, John Ogbemhe

University of Lagos

*Corresponding author: Fawaz Azeez • Presenting author: Fawaz Azeez (online)

Abstract

Sub-Saharan African economies face compounding pressures from resource-intensive linear production, rising material waste, and climate variability, yet infrastructure and industrial planning rarely integrate circular-economy principles with systems-level feedback and AI-driven decision support. This study develops and evaluates a systems-thinking framework that couples material-flow analysis with a machine-learning-based demand and waste-forecasting model to support climate-resilient, circular resource management for a mid-sized African industrial cluster. Material and energy flows across a representative manufacturing and municipal-waste network were mapped using causal-loop and stock-flow diagrams, and a supervised learning model, trained on eighteen months of production, energy and waste-generation records, forecast material-recovery potential and optimised reuse-recycle-recover pathways under three climate-stress scenarios. Application of the framework identified feedback loops responsible for 32% of avoidable material loss and showed that AI-guided routing of recoverable waste streams could reduce virgin-material demand by 24% and associated greenhouse-gas emissions by 19% relative to the current linear baseline, while improving forecast accuracy for waste generation by 21% over a rule-based benchmark. These findings demonstrate that embedding systems thinking within AI-enabled circular-economy planning can simultaneously advance climate mitigation and economic resilience, offering a transferable decision-support approach for resource-constrained industrial economies pursuing low-carbon, circular transformation.

Keywords: *circular economy; systems thinking; sustainable AI; climate resilience; material-flow analysis; resource-*

CMT-28 | Industrial & Systems Engineering
Technical Session 1C • Wednesday 18 November 2026 • 3:50 pm – 4:10 pm • Room C (IMS) • In person

CMT-28 Stochastic Robust Optimization for Multi Echelon Inventory Systems

Opeyemi Ogunpitan*

University of Lagos

*Corresponding author: Opeyemi Ogunpitan • Presenting author: Opeyemi Ogunpitan

Abstract

Modern global supply chains, including Nigerian fast-moving consumer goods distributors, face compound disruptions from pandemics, geopolitical conflict and infrastructure gaps that traditional inventory optimisation cannot absorb. Classical Economic Order Quantity and base-stock policies assume stable demand, while pure stochastic programming underestimates tail-risk cost and pure robust optimisation imposes an over-conservative premium that capital-constrained SMEs cannot afford. This project develops a hybrid stochastic–robust optimisation framework for a three-echelon inventory system that couples a manufacturer, a distributor, three retailers, external outsourcing and a centralised cash pool. A two-stage stochastic programme with twenty scenarios is combined with a budgeted robust counterpart through a convex risk-weight parameter $\lambda \in [0, 1]$, and second-stage recourse permits lateral transshipment and emergency outsourcing. All model variants were implemented in Pyomo and solved to global optimality with the HiGHS open-source solver across 44 parameter combinations on a real Kaggle supply chain dataset of 100 stock-keeping units carrying a 25.0% empirical disruption rate. The deterministic baseline reaches \$38,147; the pure stochastic model \$40,995 (7.5% premium); the pure robust model at $\Gamma = 2$ costs \$57,331 (39.8% premium). The hybrid model at $\lambda = 0.5$ settles at \$49,163 with a 100.0% fill rate and cuts worst-case cost by 12.5% at only a 19.9% premium, half the price of pure robustness. The recommended operating band $\lambda \in [0.3, 0.6]$ delivers a practically deployable, resilience-first inventory policy for developing-economy FMCG networks.

CMT-40 | Industrial & Systems Engineering
Technical Session 2C • Thursday 19 November 2026 • 12:00 pm – 12:20 pm • Room C (IMS) • In person

CMT-40 Stochastic Modeling and Optimization of Campus Shuttle Dispatch Systems Using Discrete Event Simulation: A Case Study of UNILAG Campus Cabs

Testimony Arowolo*, Patrick Olayiwola

University of Lagos

*Corresponding author: Testimony Arowolo • Presenting author: Testimony Arowolo

Abstract

Campus shuttle systems in developing cities often suffer from severe congestion. Operators typically follow an uncoordinated fill-and-go dispatch policy. This practice creates long queues and unpredictable delays. This study models and optimizes the campus cab dispatch system at the University of Lagos. The main goal is to minimize passenger wait times and eliminate road network congestion. The research team collected empirical field data across nine operational days. These records included passenger arrival counts, micro-motion vehicle loading times, and terminal queue snapshots. Student arrivals were modeled as a non-homogeneous Poisson process. Vehicle service durations followed a lognormal distribution, confirmed by a Kolmogorov-Smirnov test with p equals 0.722. A discrete-event simulation digital twin was developed in Python using SimPy. The simulation incorporated preemptive-resume priority logic to model real-world disruptions, such as twelve-minute fuel procurement runs. Across 100 Monte Carlo replications, the baseline model achieved operational validity. It captured the empirical peak queue of 28 students within its 95% confidence interval of 25.59 to 30.01. Scenario evaluations revealed that fuel scarcity expands peak queues to 33.63 students. In contrast, heavy rainfall flattens peak arrivals to 11.65 students. To optimize operations, a Comprehensive Paratransit Optimization Protocol was developed. This protocol combines a 30-second departure spacing, a 3-minute wait cap, and a 3-cab internal reserve. The protocol capped peak waiting times at 3.6 minutes and eliminated downstream bus bunching. Integrating electric vehicles further lowered peak queues to 32.14 students. This research provides a data-driven framework that balances driver income with passenger welfare.

Keywords: *campus transit; discrete-event simulation; paratransit dispatch; queuing theory*

CMT-04 | Industrial & Systems Engineering
Technical Session 2C • Thursday 19 November 2026 • 12:20 pm – 12:40 pm • Room C (IMS) • Online

CMT-04 Systematic Review of the Application of Artificial Intelligence Models to Vehicle-to-Everything (V2X) Communication Systems

Tosin Ogunrinde[1*], Kazeem Sodiq[2], Lateef Saliu[2], Solomon Salau[2], Kabiru Olatidoye[2], Oyesola Awoyoola[2], Olukayode Olopade[2], Ibrahim Ogundero[3], Latifat Oderinu[4], Owolabi Shobowale[5]

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*Corresponding author: Tosin Ogunrinde • Presenting author: Tosin Ogunrinde (online)

Abstract

Vehicle-to-Everything (V2X) communication is foundational to Intelligent Transportation Systems (ITS), enabling cooperative perception, real-time traffic management, and autonomous driving. However, stringent Quality of Service (QoS) requirements — ultra-low latency, high reliability, scalability, and security — remain difficult to meet in dynamic vehicular environments using conventional rule-based approaches. This paper presents a systematic review of AI-enabled V2X communication systems, examining how modern AI paradigms address these challenges across the communication, intelligence, and application layers of the V2X stack. Following PRISMA 2020 guidelines, 544 records were identified from major scientific databases and screened against predefined inclusion, exclusion, and quality criteria, yielding 75 studies for synthesis. Reviewed work is classified by application domain, AI methodology, evaluation environment, and network architecture, spanning deep learning, reinforcement learning, federated learning, and hybrid models. Evidence shows AI-driven V2X solutions achieve marked improvements in latency, reliability, spectral efficiency, traffic-flow optimisation, and security resilience over traditional approaches. Persistent gaps remain, including reliance on simulation-based validation, in-vehicle hardware constraints, non-IID data challenges, and unresolved security and interoperability issues. The paper concludes by outlining emerging trends — 6G-enabled V2X, generative AI, reconfigurable intelligent surfaces, and privacy-preserving decentralised learning — that will shape AI-enabled V2X's transition from theoretical models to scalable, real-world ITS deployments. Keywords: Vehicle-to-Everything (V2X) Communication; Artificial Intelligence; Deep Reinforcement Learning; Federated Learning; Intelligent Transportation Systems; 6G Networks

Keywords: *Vehicle-to-Everything (V2X) Communication; Artificial Intelligence; Deep Reinforcement Learning; Federated Learning; Intelligent Transportation Systems; 6G Networks*

CMT-19 | Industrial & Systems Engineering
Technical Session 2C • Thursday 19 November 2026 • 12:40 pm – 1:00 pm • Room C (IMS) • Online

CMT-19 Two-Stage Stochastic–Robust Optimization of Sustainable Logistics Networks with Carbon-Constrained, Energy-Efficient Routing

Ayomikun Ayanlowo*, John Ogbemhe

University Of Lagos

*Corresponding author: Ayomikun Ayanlowo • Presenting author: Ayomikun Ayanlowo (online)

Abstract

In this study, a two-stage stochastic-robust optimization approach to sustainable logistics network design and carbon emission constrained energy-efficient routing under demand and travel time uncertainty was proposed and tested. Although the customer demand, travel time, traffic conditions and other operating parameters may change, the study was conducted on the limitations of deterministic logistics network optimization models. Three Mixed-Integer Linear Programming (MILP) formulations were created and analyzed: deterministic, two-stage stochastic and integrated two-stage stochastic-robust. The computational study was performed on the road-based logistics network of Lagos state, Nigeria, which has 25 nodes (five potential distribution centres and 20 customer demand zones) for the three scenarios: Dry, Moderate Rain and Heavy Rain. The deterministic formulation had the lowest expected operating cost of ₦42,582,556.59, the stochastic formulation had the expected operating cost of ₦44,693,525.94 and the stochastic-robust formulation had the expected operating cost of ₦44,777,077.77. The stochastic based formulations resulted in lower energy consumption and carbon emissions. The stochastic-robust formulation provided more robust level of protection against adverse operating conditions and worst case performance. Based on the research, the conclusion is that sustainable logistics optimization must be comprehensive and must take into account the economic efficiency, environmental performance and uncertainty resistance. Keywords: demand uncertainty; travel time uncertainty; mixed-integer linear programming; Lagos State; economic efficiency.

Keywords: *demand uncertainty; travel time uncertainty; mixed-integer linear program-*

E-69 | Industrial & Systems Engineering
Technical Session 2C • Thursday 19 November 2026 • 1:00 pm – 1:20 pm • Room C (IMS) • In person

E-69 Automated Grading for Nigerian Higher Institutions Utilising Multimodal Large Language Model Inference

Solomon Bibinu*, Samuel Oluseye-Are

Department of Systems Engineering, Faculty of Engineering, University of Lagos

*Corresponding author: Solomon Bibinu • Presenting author: Solomon Bibinu

Abstract

Manual grading of handwritten examinations in large Nigerian universities is slow, inconsistent, and difficult to scale, while existing automated grading systems are typically domain-specific, assume typed input, and offer little pedagogical transparency. This study designs and evaluates a modular, multimodal grading pipeline that combines computer-vision preprocessing, handwriting recognition, rubric-conditioned prompting, and a QLoRA fine-tuned LLaMA 3.2-3B model, delivered through a FastAPI web application. Using examination scripts from two University of Lagos courses, MME302 (Properties of Materials) and GEG401 (Technical Communication), the study examines pre-fine-tuning baselines, the effect of rubric alignment, and generalisation decay across a 3 × 3 fine-tuning matrix (1, 3, and 5 training scripts × 1, 3, and 5 epochs). A domain classifier trained on the r/AskScience corpus showed that the two courses are statistically distinguishable (permutation $p = .0002$) yet overlapping. A multimodal baseline reached a quadratic weighted kappa (QWK) of 0.682 in-distribution and 0.440 out-of-distribution, whereas an OCR-then-LLM baseline performed near or below chance. Fine-tuning raised in-distribution QWK to 0.937 (five scripts, five epochs) while out-of-distribution QWK fell to −0.243, demonstrating measurable generalisation decay. Mean end-to-end latency was 65.3 s per script. Findings are exploratory because evaluation sets were small (3–6 scripts). Results indicate that rubric alignment and input modality matter more than model adaptation alone, and that adaptation should be constrained to preserve cross-course validity.

Keywords: *automated grading; large language models; handwriting recognition; QLoRA; generalisation; Nigerian higher education*

CMT-24 | Industrial & Systems Engineering
Technical Session 3C • Thursday 19 November 2026 • 2:30 pm – 2:50 pm • Room C (IMS) • Online

CMT-24 Stochastic–Robust Vehicle Routing Optimization for Last-Mile Delivery Under Demand and Travel-Time Uncertainty

Daniel Ajayi[1*], **John Ogbemhe**[2]

[1]*University of Lagos*
[2]*University Of Lagos*

*Corresponding author: Daniel Ajayi • Presenting author: Daniel Ajayi (online)

Abstract

Last-mile delivery is conventionally planned as a Capacitated Vehicle Routing Problem (CVRP) that assumes customer demand and travel time are known before dispatch. Neither assumption holds in practice, and the resulting cost-optimal plan is structurally fragile: minimising distance consumes exactly the vehicle capacity that would otherwise absorb variability. This study developed an integrated stochastic–robust CVRP that treats the two sources of uncertainty according to their physical character. Demand uncertainty was represented by a two-stage stochastic programme with recourse, priced through an overflow penalty; travel-time uncertainty was represented by a one-sided budgeted uncertainty set, reduced by linear-programming duality to a compact robust counterpart. The result is a single mixed-integer linear programme governed by two interpretable budgets, Γd and Γt, stating how many customers and arcs on a route may simultaneously realise their worst case. Standard CVRPLIB benchmark instances were extended into stochastic–robust instances by a documented augmentation protocol and solved exactly on an open-source Python, PuLP and HiGHS stack. The deterministic benchmark reproduced published CVRPLIB optima exactly. Out-of-sample simulation over 2,000 scenarios per instance shows the cost-optimal deterministic plan violates vehicle capacity on 43–95% of simulated days, while the integrated model restores reliability to the attainable ceiling for a premium of 16–26%. Because total cost is affine in the assumed failure cost once routes are fixed, a break-even failure cost θ* is obtained in closed form, at which protection stops being a premium and becomes the cheaper plan; this threshold is shown to be invariant across a fifty-fold range of the failure cost. The results give an operator-facing decision rule for whether robustness is worth its cost, without requiring an assumed probability distribution.

Keywords: *Vehicle Routing Problem; Stochastic Programming; Robust Optimization; Last-Mile*

CMT-30 | Industrial & Systems Engineering
Technical Session 3C • Thursday 19 November 2026 • 2:50 pm – 3:10 pm • Room C (IMS) • Online

CMT-30 IoT-Enabled Real-Time Logistics Tracking and Delay Prediction Using GNN-LSTM for Supply Chain Visibility

David Dickson[1*], **John Ogbemhe**[2]

[1]*University Of Lagos*
[2]*University of Lagos*

*Corresponding author: David Dickson • Presenting author: David Dickson (online)

Abstract

The drastic cost implications of frieght congestion on the Lagos-Apapa corridor demands the need for tracking systems that offer real-time visibility of vehicle location as well as anticipate points of congestion buildup across a port network. The aim of this study is to develop a framework the combines a specific-purpose edge IOT tracking device with a hybrid Graph Neural-Long Short-Term Memory model. The tracker consists of GNSS, cellular transmission and on-board storage to measure quatities like node dwell time, edge travel time etc. The tracker is also equipped with the ability to store and forward buffers to toelrate intermittent connectivity. The graph based network will be fed with inputs of data from external sources, while the model data has to come from multiple years of data collection along the Lagos Apapa corridor. The framwork should emonstrate that anticipatory, network-level delay prediciton is achievable wit affordable hardware in a developing port corridor, offering a transferable basis for proactive frieght management and more resillient transport infrastructure.

Keywords: *freight logistics; delay prediction; edge computing; graph neural networks; port corridor; intelligent transportation systems*

E-70 | Industrial & Systems Engineering
Technical Session 3C • Thursday 19 November 2026 • 3:30 pm – 3:50 pm • Room C (IMS) • In person

E-70 A Low-Cost Ducted Indoor Air Purification System for Public Toilets: Design, Prototyping and Predicted Performance

Comfort O. Folorunso*, Abolade Omiyale, Wasiu A. Raheem, Olumide F. Odeyinka, Emmanuel A. Olubiyi, Oluwafemi Ipinnimo, Olayiwola P. Shola

Department of Systems Engineering, Faculty of Engineering, University of Lagos

*Corresponding author: Comfort O. Folorunso • Presenting author: Comfort O. Folorunso

Abstract

Public toilets in Nigerian universities are among the most polluted indoor spaces on campus. A survey at one of the public university in Lagos State found restroom air above recommended limits for airborne bacteria, fungi, sulphur dioxide and relative humidity, and the main cause is poor air exchange rather than unusually strong sources. This paper presents the design and prototyping of a low-cost Ducted Indoor Air Purification System (DIAPS) that draws air out of a toilet compartment, passes it through a treatment train and replaces it with purified air. The ventilation duty was sized with a once-through mass balance driven by the published campus data, and the operating point of each fan was found from its pressure-flow curve and the resistance of the system it drives. The prototype was built by hand from Lagos market components and repurposed packaging. In the exhaust train a 12 V centrifugal blower pushes air through pleated cabin-filter media and a charcoal bed; the supply train carries an axial fan. The model predicts an exhaust flow of 56.5 m^3/h, or 4.7 air changes per hour in a 12 m^3 compartment, at a rated load of 32.4 W. At this flow, airborne bacteria, fungi and sulphur dioxide are predicted to fall below their thresholds within 6, 15 and 24 minutes and to settle 67 to 86 % below baseline, while PM2.5 is held at the outdoor level. The unrestricted supply fan is predicted to over-pressurise the compartment, so a supply restrictor is required.

Keywords: *public toilet; indoor air quality; once-through ventilation; low-cost air purification; air changes per hour; Nigeria*

E-71 | Industrial & Systems Engineering
Technical Session 4C • Thursday 19 November 2026 • 4:20 pm – 4:40 pm • Room C (IMS) • In person

E-71 AgroScan AI for Multi-Crop Plant Disease Diagnosis and Knowledge Graph-Grounded Advisory Generation

Comfort O. Folorunso*, Olumide F. Odeyinka, Wasiu A. Raheem, Abolade Omiyale, Peter A. Fagbola, Oluwafemi Ipinnimo, Olayiwola P. Shola

Department of Systems Engineering, Faculty of Engineering, University of Lagos

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Abstract

Image-based plant disease classifiers provide diagnostic labels, but an advisory system must also connect those labels to relevant management information. This study developed AgroScan AI, a three-stage pipeline that combines image classification, deterministic retrieval from a crop-scoped knowledge graph, and advisory generation using a fine-tuned T5-small model. An earlier controlled comparison of six architectures on cassava selected the hybrid model termed CoAtNet in this study, which achieved 83.40% accuracy and 0.7318 macro-F1. A separate experimental phase trained this architecture independently for ten crops using a longer training schedule and stronger augmentation. Across 86,515 reported training images and 42 crop-specific labels, reported test accuracy ranged from 90.41% to 100.00%; excluding the questionable strawberry result, the range was 90.41–99.89%. The graph contained 336 nodes, 376 edges, and 43 entries, and supplied 258 input–target pairs for decoder fine-tuning. An explicit label translation layer mapped 33 of 42 classifier labels to graph entries; the remaining nine returned no information. Five decoder-only checks reported no unsupported factual content, and a detailed cassava end-to-end example preserved the retrieved facts and treatment order. Five engineering defects exposed failures in metadata, graph scoping, label interfaces, and deployed artefacts. These results support the feasibility of integrating classification with auditable advisory generation, while leaving field performance and broader generation reliability unestablished. Graph-derived training targets encourage factual consistency but do not mathematically guarantee hallucination-free inference. Expert assessment of graph content, broader factuality evaluation, and field validation remain necessary.

Keywords: *plant disease classification; hybrid CNN–Transformer; knowledge graph; retrieval-augmented generation; T5; agricultural advisory systems; system verification*

Also submitted as CMT-12; presented once.

E-72 | Industrial & Systems Engineering
Technical Session 4C • Thursday 19 November 2026 • 4:40 pm – 5:00 pm • Room C (IMS) • In person

E-72 Design, Simulation and Fabrication of a TEC–PCM Hybrid Cooling Container for Maximising Fruit Shelf Life Under Tropical Conditions in Nigeria

Comfort O. Folorunso*, Wasiu A. Raheem, Olumide F. Odeyinka, Abolade Omiyale, Zumayah O. Isiak, Malik T. Kareem, Oluwafemi Ipinnimo, Olayiwola P. Shola

Department of Systems Engineering, Faculty of Engineering, University of Lagos

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Abstract

Post-harvest losses of fruit and vegetables in Nigeria are severe, driven by tropical heat and the absence of an affordable, reliable cold chain. This paper presents the design, simulation and fabrication of a portable thermoelectric–phase-change-material (TEC–PCM) hybrid cooling container intended to hold cucumber and tomato at 10–15 °C under a 32 °C ambient, with autonomous operation through power outages. A steady-state thermal analysis set the design cooling load (≈10 W); two TEC1-12706 Peltier modules were selected and operated in series at a reduced input (6 V × 3 A = 18 W per module) to favour efficiency, with finned aluminium heat sinks and forced-air cooling for hot-side heat rejection, and a paraffin PCM store sized for at least 12 h of autonomous cooling. The control and power electronics (an ESP32 microcontroller, a DHT22 sensor and a relay-switched 12 V load) were simulated in Proteus prior to assembly, and a prototype was fabricated with a welded steel chassis and an aluminium internal chamber. On test, the chamber reached a steady state of 21–23 °C, above the 10–15 °C target, in about 5 h, drew about 151 W for only ~18 W of useful cooling (a system COP of about 0.12), held cold for 11–12 h on the PCM after power was removed, and the loaded unit weighed 24.9 kg. The temperature shortfall is attributed to a highly conductive, poorly sealed metal chamber, a choked hot-side exhaust that cannot reject the modules' waste heat, thermal bridging of that waste heat back into the cold chamber, and the reduced net cooling capacity of the series-connected modules. The study validates the design-and-build methodology and the PCM-first autonomy concept, and identifies the specific improvements (thermal breaks, airtight sealing, a redesigned exhaust and greater net cooling capacity) needed to reach the target storage temperature.

Keywords: *thermoelectric cooling; phase change material; post-harvest loss; cold chain; Peltier; Nigeria*

Subtheme 6: Geomatics Engineering

Positioning and geodesy; remote sensing and image analysis; LiDAR and point clouds; GIS; hydrographic applications.

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E-63	Seasonal Structure and Multi-Decadal Stability of Cloud Cover Over the Lagos Lagoon, Nigeria, 2000–2025: A Landsat-Based Assessment	Seyi Emmanuel Akinyemi	TS2D, Thu 19 Nov, 12:00 pm, Room D (IMS)	71
E-64	Field Determination of Single Beam Echo Sounder System Parameter Error and the Role of Sound Velocity, University of Lagos Lagoon	Jesse Inyamah	TS2D, Thu 19 Nov, 12:20 pm, Room D (IMS)	72
E-65	Vertical and Spatial Variability of Sound Velocity in a Shallow Tropical Lagoon: Implications for Echo Sounding at the UNILAG Waterfront	Tosin J. Salami	TS2D, Thu 19 Nov, 12:40 pm, Room D (IMS)	73
E-66	Multi-Sensor Hydrographic Survey and Formal Safety Assessment of Navigation Risk in Five Cowries Creek, Lagos, Nigeria	M. T. Salaudeen-Rauf	TS2D, Thu 19 Nov, 1:00 pm, Room D (IMS)	74

CMT-31 | Geomatics Engineering
Technical Session 1D • Wednesday 18 November 2026 • 2:30 pm – 2:50 pm • Room D (IMS) • In person

CMT-31 Sentinel-1 SAR-Based Land Cover Classification and Object Detection for Agricultural Monitoring in Ita-Egbe, Nigeria

Moshood Mustapha[1*], **Esther Makinde**[2]

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*Corresponding author: Moshood Mustapha • Presenting author: Moshood Mustapha

Abstract

Persistent cloud cover over humid tropical landscapes limits the utility of optical satellite imagery for agricultural land cover monitoring, yet timely information on land use dynamics is critical for food security assessment and sustainable resource management in sub-Saharan Africa. This study applies Sentinel-1 Synthetic Aperture Radar (SAR) imagery to land cover classification and automated object detection in the Ita-Egbe, Ogun State, Nigeria, a 314 km² catchment spanning secondary forest, smallholder agriculture, water bodies and peri-urban land. Ground Range Detected scenes in Interferometric Wide swath mode were pre-processed in ESA SNAP through orbit correction, thermal noise removal, gamma-nought radiometric calibration, Lee Sigma 7×7 speckle filtering and Range-Doppler terrain correction to 10 m resolution (UTM Zone 31N). A supervised classifier applied to the dual-polarisation composite achieved an overall accuracy of 75.7% (Cohen's kappa 0.72) across six classes: light forest, heavy forest, plantation, water, bare soil and built-up. A YOLOv8s detector fine-tuned on 256×256 pixel SAR tiles over 150 epochs returned an overall mean average precision at IoU 0.50 of 0.083; the water class alone yielded reliable detection (mAP50 0.495, precision 1.0, recall 0.5), whilst the remaining five classes produced zero detections, exposing the domain gap between SAR backscatter texture and optical-domain detector architectures. These results confirm the viability of SAR-based classification for cloud-obstructed tropical agricultural monitoring and identify object detection on SAR imagery as a research frontier requiring domain-specific adaptation and larger annotated training datasets. Word count: 234

Keywords: *Sentinel-1 SAR; land cover classification; YOLOv8; agricultural monitoring; SNAP pre-processing; Nigeria*

CMT-36 | Geomatics Engineering
Technical Session 1D • Wednesday 18 November 2026 • 2:50 pm – 3:10 pm • Room D (IMS) • In person

CMT-36 Spatial-Predictive Modeling of Peri-Urban Household Water Consumption Using Spatially Blocked Machine Learning Technique

Andrew Taiwo*, Joseph Olusina, Adewale Hamid-Mosaku

University of Lagos

*Corresponding author: Andrew Taiwo • Presenting author: Andrew Taiwo

Abstract

Rapid growth of peri-urban settlements in developing regions creates severe municipal water deficits that standard temporal forecasting models fail to capture. This study presents an empirical, scenario-driven spatial predictive modeling framework to forecast water use in 2035 in households in the unmetered Nyanya-Mararaba Town, Nigeria. 1,200 households across 12 wards were surveyed across wet and dry seasons yielding 2,400 observation instances. To eliminate spatial data leakage, spatial block cross-validation framework was implemented via unsupervised K-Means coordinate clustering (geographic folds). Machine learning algorithms (Ordinary Least Squares [OLS], Support Vector Regression [SVR], Random Forest [RF], Extreme Gradient Boosting [XGBoost], and MultiLinear Perceptron [MLP]) were incorporated with socioeconomic metrics, CHIRPS rainfall, Land Surface Temperature (), and geospatial features (GSF) such as shortest distance, height difference, and travel time. Results demonstrate that tree-based ensemble models achieved exceptional predictive performance, with XGBoost and RF attaining out-of-sample across seasons. A 4-tier ablation study proved that integrating GSF triggers a massive performance lift, boosting from (socioeconomic baseline) to over . SHapley Additive exPlanations (SHAP) revealed non-linear distance decay (meters) and elevation penalty thresholds governing water acquisition. Scenario-driven spatial simulations project that mean household water consumption will reach 402.27 liters/day (aggregating to 965,450.20 liters/day) across the study area by 2035, with severe deficit hotspots concentrating in high-elevation peripheral wards under rapid demographic growth (to annual increase). These findings provide a robust operational blueprint for decentralized water infrastructure planning in rapidly growing peri-urban settlements.

Keywords: *water security; unmetered settlements; XGBoost regressor; geographic data leakage; local spatial autocorrelation*

CMT-41 | Geomatics Engineering
Technical Session 1D • Wednesday 18 November 2026 • 3:10 pm – 3:30 pm • Room D (IMS) • In person

CMT-41 UAV-Referenced Calibration of Sentinel-2 Satellite-Derived Bathymetry on a Data-Scarce Open Coast: The Eti-Osa Shoreline, Lagos, Nigeria

Michael Feyisetan[1*], **Oludayo Abiodun**[2]

[1]*Institute of Maritime Studies, University of Lagos*
[2]*Department of Surveying and Geoinformatics, University of Lagos*

*Corresponding author: Michael Feyisetan • Presenting author: Michael Feyisetan

Abstract

Shallow nearshore bathymetry is largely unavailable for the Nigerian open coast, where acoustic survey is costly and least effective in the surf zone, yet such data underpin coastal protection, erosion management and safe navigation. This study evaluated whether a dense unmanned aerial vehicle (UAV) photogrammetric depth dataset can calibrate and validate Sentinel-2 satellite- derived bathymetry (SDB) where chart and acoustic reference depths are absent. Structure-from- motion depths from a groyne-protected corridor at Eti-Osa, Lagos, were refraction-corrected point by point and aggregated to 870 Sentinel-2 pixels between 0.228 m and 5.610 m, which were divided by 30 m spatial blocks into 697 calibration and 173 validation observations. Atmospherically corrected reflectance from one scene was used to calibrate the Stumpf log-band- ratio model in blue-green and blue-red configurations and an empirical logarithmic blue-green model. On independent validation, the Stumpf blue-green model achieves a coefficient of determination of 0.677, a root-mean-square error of 1.018 m and a mean absolute error of 0.835 m, and outperforms the blue-red configuration in every depth interval. The empirical model differs from it by a mean absolute 0.070 m over 3,110 pixels. Applied without recalibration to an adjacent shoreline, the primary model places 99.57 % of 2,538 predictions within the calibration depth range. The resulting reconnaissance-grade surface, referenced to mean sea level, shows that low- cost UAV photogrammetry can supply the reference data that satellite bathymetry requires, supporting survey planning and the monitoring of coastal-protection structures on data-scarce coasts.

Keywords: *hydrographic surveying; coastal remote sensing; structure-from-motion*

CMT-47 | Geomatics Engineering
Technical Session 1D • Wednesday 18 November 2026 • 3:30 pm – 3:50 pm • Room D (IMS) • Online

CMT-47 Predicting Land Use/Land Cover Dynamics for Urban Planning and Flood Risk Mitigation in Lagos State Using the MOLUSCE Cellular Automata

Favour Taiwo*, Emmanuel Ayodele, A. O. Alabi, F. O. Kehinde, O. C. Olawoye

University of Lagos

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Abstract

Multi-temporal land use and land cover (LULC) mapping provides a retrospective record of change, while effective governance requires forward-looking forecasts. This study presents a Cellular Automata (CA) prediction of land use and land cover (LULC) change in Lagos State for the year 2028. High-accuracy multi-temporal LULC maps (2016, 2019, 2022 and 2025) previously generated from fused Sentinel-1 Synthetic Aperture Radar and Sentinel-2 optical data served as the primary inputs. Historical transition matrices derived from the maps, together with a Digital Elevation Model as the sole spatial driver, were used within the QGIS MOLUSCE plugin (Artificial Neural Network method) to train and validate a CA model. The model reproduced the observed 2022 and 2025 landscapes with correctness ratings of 86.62 % and 85.36 %, respectively. The 2028 projection indicates further expansion of built-up areas by 11,660.45 hectares (from 25.80% to 28.98% of the state), driven primarily by conversion of bare land. Vegetation is projected to decline by 1,097.48 hectares while water bodies remain essentially stable. The results provide a spatially explicit short- term forecast that can support anticipatory urban planning and flood-risk mitigation in this rapidly urbanising coastal megacity, in line with Sustainable Development Goal 9.

Keywords: *Prediction; MOLUSCE; SDG; Resilient Infrastructure; Urban Expansion; Transition*

E-61 | Geomatics Engineering
Technical Session 1D • Wednesday 18 November 2026 • 3:50 pm – 4:10 pm • Room D (IMS) • In person

E-61 Assessment of Sediment Deposition and Reservoir Storage Capacity Loss at Agba Dam, Ilorin, Using Apache 5 Autonomous Surface Vehicle-Based Single-Beam Bathymetric Survey

Abubakar A. Adebayo[1*], **Oludayo E. Abiodun**[2], **A. A. Abubakar**[1], **Micheal D. Feyisetan**[1]

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Abstract

Agba Dam, constructed in 1952 across River Agba in Ilorin, Kwara State, Nigeria, is the first dam built in the state and remains a critical source of raw water supply to key areas of the Ilorin metropolis. Progressive sedimentation has raised concerns about storage capacity reduction, yet previous investigations relied on sparse point sampling and lacked complete, high-resolution bathymetric coverage of the entire reservoir (approximately 24–25 hectares). This study provides the first comprehensive, reservoir-wide assessment of sediment deposition and capacity loss using a CHC Apache 5 Autonomous Surface Vehicle (USV) equipped with a single-beam echo sounder and integrated RTK-GNSS positioning. A geodetic control network was established on the Minna Datum (UTM Zone 31N). Systematic bathymetric survey lines were executed autonomously across the full open-water area under favourable conditions near full supply level. After rigorous data cleaning, 4,760 valid soundings were retained and processed to generate a high-resolution Digital Terrain Model (DTM), slope map, Elevation-Area-Volume (EAV) relationships, and an interpretive bed-morphology zonation of the entire reservoir bed. Results show that the current storage capacity at the surveyed pool level of 320.29 m is 1,264,190 m³, compared with the original design capacity of 1,344,000 m³. This corresponds to an estimated sediment volume of 79,810 m³ and a capacity loss of 5.9%. The relatively modest rate is consistent with the predominantly spring-fed hydrology of the reservoir. Morphologically, the bed is dominated by an open deep basin (63.1% of the surveyed footprint), with shallow margins (≤ 2 m) occupying 12.2%, a moderate-slope transition zone 18.8%, and a dam-proximal deep pool 5.4%. An independent area-based cross- validation confirmed near-complete spatial coverage (computed area 25.04 ha versus reported 25.3 ha). The study delivers the first spatially continuous bathymetric baseline for Agba Dam, demonstrates the practical applicability of USV-based single-beam technology for small tropical inland reservoirs in Nigeria, and provides immediately usable management products (DTM, EAV curves, and zonation maps).

Keywords: *hydrographic surveying; reservoir sedimentation; autonomous surface vehicle; single-beam*

E-67 | Geomatics Engineering
Technical Session 1D • Wednesday 18 November 2026 • 4:10 pm – 4:30 pm • Room D (IMS) • In person

E-67 A Staged, Uncertainty-Aware Digital Twin Framework for Relative Sea-Level Rise in Data-Scarce Coastal Cities: A Review-Based Design for Lagos, Nigeria

A. I. Hamid-Mosaku, Adewale I. Adewuyi*, Ibrahim O. Shittu, Theophilus O. Attah, T. A. Ojeniran

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Abstract

Coastal cities in Sub-Saharan Africa face intensifying sea-level hazards but lack the dense tide-gauge networks, high-accuracy elevation data and computing infrastructure on which most digital twin (DT) prototypes depend. This study conducted a purposive, structured narrative review of 28 sources (25 journal articles, two book chapters and one conference abstract) to derive design requirements for a DT of relative sea-level rise. The searches have not been replicated in indexed databases, so the findings are indicative patterns in the retrieved sources rather than systematically established evidence. In those sources, most coastal DT proposals are conceptual or operate at Earth-system scale, with few city-scale implementations in the Global South; digital elevation model (DEM) vertical error and omission of vertical land motion (VLM), the two dominant error sources in elevation-based assessment, are well documented but seldom propagated explicitly; and the label "digital twin" is often applied to systems without automated bidirectional data flow. Synthesising these patterns, the paper proposes STAR-Twin, a conceptual five-layer framework that couples a maturity-staged pathway (digital model, digital shadow, digital twin) with a tiered inundation engine and Monte Carlo uncertainty propagation. A traceable requirements table, stage-gate criteria and a validation protocol with provisional acceptance thresholds are specified, and a proposed Lagos instantiation identifies data sources and stage gates. The framework has not been implemented or empirically validated.

Keywords: *digital twin; relative sea-level rise; vertical land motion; uncertainty propagation; data-scarce coastal cities; Lagos*

E-63 | Geomatics Engineering
Technical Session 2D • Thursday 19 November 2026 • 12:00 pm – 12:20 pm • Room D (IMS) • Online

E-63 Seasonal Structure and Multi-Decadal Stability of Cloud Cover Over the Lagos Lagoon, Nigeria, 2000–2025: A Landsat-Based Assessment

Seyi Emmanuel Akinyemi, Tosin J. Salami*, Jesse Inyamah, Abiodun Olawale Alabi, Alfred Sunday Alademomi

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*Corresponding author: Tosin J. Salami • Presenting author: Seyi Emmanuel Akinyemi (online)

Abstract

Persistent cloud cover limits optical remote sensing over the humid tropical coast, yet the long-term behaviour of cloud over the Lagos Lagoon, the moisture source and thermal regulator of the Lagos megacity, has received little quantitative attention. This study examined seasonal and multi-decadal variability in cloud cover over the lagoon from 2000 to 2025 using 52 Landsat 7 ETM+ and Landsat 8 OLI Collection 2 Level-2 scenes (path 191, row 055), one dry-season and one rainy-season scene for each year. Scene cloud-cover values were compiled from the product metadata, summarised as annual two-scene means, and tested with independent and paired t-tests, linear regression and the Mann–Kendall test; cloud was also mapped by ISODATA unsupervised classification in ERDAS Imagine for selected years. The annual mean ranged from 32.0% (2000) to 94.2% (2013), with a second peak in 2023 (93.9%). No monotonic trend was detected (Kendall's $\tau = 0.157$, $p = 0.273$), and the earlier (2000–2012) and later (2013–2025) eras did not differ significantly (55.4% versus 64.3%; $t(24) = -1.376$, $p = 0.181$). By contrast, rainy-season scenes (mean 83.4%) were far cloudier than dry-season scenes (mean 36.3%; $t(50) = -7.62$, $p < 0.001$; Cohen's $d = 2.11$), and no rainy-season scene had less than 20% cloud. The results indicate a stable but strongly seasonal and episodically anomalous cloud regime, with direct implications for optical image acquisition planning and for the use of radar data in rainy-season coastal monitoring.

Keywords: *cloud cover; Landsat; Lagos Lagoon; remote sensing; seasonal variability; hypothesis testing*

E-64 | Geomatics Engineering
Technical Session 2D • Thursday 19 November 2026 • 12:20 pm – 12:40 pm • Room D (IMS) • Online

E-64 Field Determination of Single Beam Echo Sounder System Parameter Error and the Role of Sound Velocity, University of Lagos Lagoon

Jesse Inyamah, Tosin J. Salami*, Seyi Emmanuel Akinyemi, Abiodun Olawale Alabi

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*Corresponding author: Tosin J. Salami • Presenting author: Jesse Inyamah (online)

Abstract

Systematic error in single beam echo sounding is conventionally modelled as an index error, constant with depth, and a scale error proportional to depth, yet the two are seldom determined with stated uncertainties in routine inshore practice. This study determined the system parameter error of a South SDE-series single beam echo sounder (200 kHz) from boat-based observations on the University of Lagos lagoon, Nigeria. The transducer was displaced in nominal 0.1 m steps over measured depths of 1.15–3.00 m, in ascending and descending sequences, under the instrument's default sound velocity (1408 m/s) and under 1506 m/s measured with a sound velocity meter. Observed depth was regressed on measured depth (O = A + BM) by least squares and tested for significance, directional hysteresis and compliance with IHO S-44. Under 1408 m/s the sounder under-read by 17.0 cm on average, close to the 14.8 cm expected from the velocity mismatch alone; with the scale factor fixed at the velocity ratio, the residual offset was only −2.2 cm. The free-fit intercepts (−22.3 and −25.6 cm) and slopes above unity were physically inadmissible, reflecting strong intercept–slope correlation ($r \approx -0.98$) over the short depth span. Under 1506 m/s neither parameter differed significantly from its ideal value (descending: A = +0.32 ± 2.58 cm, B = 0.9911 ± 0.0136), and every reading met the S-44 Exclusive Order. Significant hysteresis (3.8–11.9 cm) indicated instability of the boat-referenced depth datum. Direct measurement of sound velocity is therefore the decisive calibration step for low-cost inshore echo sounding.

Keywords: *single beam echo sounder; calibration; index error; scale error; sound velocity; IHO S-44*

E-65 | Geomatics Engineering
Technical Session 2D • Thursday 19 November 2026 • 12:40 pm – 1:00 pm • Room D (IMS) • In person

E-65 Vertical and Spatial Variability of Sound Velocity in a Shallow Tropical Lagoon: Implications for Echo Sounding at the UNILAG Waterfront

Tosin J. Salami*, Abiodun Olawale Alabi, Alfred Sunday Alademomi, Ayomide Samuel Akinyosoye, Jesse Inyamah

Department of Surveying and Geoinformatics, Faculty of Engineering, University of Lagos

*Corresponding author: Tosin J. Salami • Presenting author: Tosin J. Salami

Abstract

Sound velocity governs the conversion of acoustic travel time to depth, yet hydrographic work in Nigerian lagoons commonly assumes a nominal 1500 m/s. This study measured sound velocity, temperature and pressure at ten stations along the University of Lagos waterfront, Lagos Lagoon, on 4 September 2026, using a Hydro-Tech SVP1500 profiler (19 casts at 8 Hz). Raw records were decoded, pressure was converted to depth, and casts were quality-controlled to remove in-air records and bottom-contact artefacts, which depressed readings by up to 46 m/s while the probe rested on the bed. Water depths ranged from about 1.0 m to 7.0 m, and temperature varied only between 27.6 °C and 28.6 °C. The eight shallow stations (≤3.1 m) were vertically homogeneous, with depth-mean sound velocities of 1505.9–1507.1 m/s, implying near-fresh water of about 1.5–3.0 PSU. In contrast, the two deepest stations displayed sharp haloclines: sound velocity rose by about 6.5 m/s below 3.6 m at Station 6 (7.0 m deep) and by up to 18 m/s below 1.9 m at Station 8 (5.0 m deep), indicating retained saline bottom water of roughly 8 and 15 PSU. Depth-mean velocities therefore ranged from 1505.9 to 1512.4 m/s. Using 1500 m/s would cause echo-sounder under-reading of 0.39–0.82%, or 0.5–4.2 cm, which is up to 16% of the IHO S-44 Special Order total vertical uncertainty. Sound velocity profiling is therefore recommended in the deeper, stratified depressions of the lagoon, where single-value corrections are least reliable.

Keywords: *sound velocity profile; halocline; Lagos Lagoon; echo sounding; hydrographic survey; IHO S-44*

E-66 | Geomatics Engineering
Technical Session 2D • Thursday 19 November 2026 • 1:00 pm – 1:20 pm • Room D (IMS) • Online

E-66 Multi-Sensor Hydrographic Survey and Formal Safety Assessment of Navigation Risk in Five Cowries Creek, Lagos, Nigeria

M. T. Salaudeen-Rauf, O. A. Jolaosho, O. T. Badejo, P. Evarie, T. J. Salami*, R. Adekola

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*Corresponding author: T. J. Salami • Presenting author: M. T. Salaudeen-Rauf (online)

Abstract

Five Cowries Creek is the principal inland waterway link between Lagos Harbour and the Lagos Lagoon, yet its only published systematic depth record is a decade old and no integrated seabed or navigation risk assessment exists for it. A three-sensor hydrographic survey, comprising single-beam bathymetry, dual-channel side scan sonar and a towed total-field magnetometer, was carried out, and the International Maritime Organization Formal Safety Assessment framework was applied to the results. Sounding on 3 August 2026 produced 6,430 fixes, of which 6,240 were accepted. Positions were obtained by standalone satellite navigation on WGS 84 / UTM Zone 31N, and depths were reduced to a provisional Mean Lower Low Water datum using predicted tides. Reduced depths ranged from 0.54 m to 8.53 m (mean 4.90 m), with a continuous channel of 7–8 m along the thalweg; 0.17 km² of margin was shallower than 2 m, including a shoal platform of 0.081 km² beside the Lekki-Ikoyi Link Bridge. Thirty acoustic contacts and twenty-six magnetic anomalies were identified, with coincident targets on the southern bridge approach. Estimated total horizontal and vertical uncertainties of 3–5 m and 0.46 m meet the uncertainty limits of Order 1a of the International Hydrographic Organization standard on an a priori basis, although its coverage and feature-detection conditions were not met. A one-dimensional tidal model, not validated by observation, gave indicative spring velocities of 0.7–1.0 m/s. Vessel collision in the confined terminal approach and human factors were rated intolerable, and low-cost operational controls rank above dredging.

Keywords: *hydrographic survey; bathymetry; side scan sonar; magnetometer; formal safety assessment; inland waterway navigation*

Subtheme 7: Energy & Petroleum Engineering

Hydrogen, biofuels and geologic carbon storage; EOR, reservoir modelling and production optimisation; pipeline integrity and flow assurance.

Paper	Title	Presenter	Session and time	Page
CMT-10	Machine-Learning Surrogate Modeling for Real-Time Perforation/Completion Design Optimization in Niger Delta Reservoirs	Oyine Belleh	TS4A, Thu 19 Nov, 4:00 pm, Room A (IMS)	76

CMT-10 | Energy & Petroleum Engineering
Technical Session 4A • Thursday 19 November 2026 • 4:00 pm – 4:20 pm • Room A (IMS) • In person

CMT-10 Machine-Learning Surrogate Modeling for Real-Time Perforation/Completion Design Optimization in Niger Delta Reservoirs

Oyine Belleh[1*], Wilfred Okologume[1], Promise Ekeh[2], Jude Udeh[1]

[1]*DEPARTMENT OF PETROLEUM ENGINEERING,FEDERAL UNIVERSITY OF PETROLEUM RESOURCES EFFURUN*
[2]*DEPARTMENT OF NATURAL GAS ENGINEERING,FEDERAL UNIVERSITY OF PETROLEUM RESOURCES EFFURUN*

*Corresponding author: Oyine Belleh • Presenting author: Oyine Belleh

Abstract

Rigorous, risk-adjusted (P10/P50/P90) completion-design guidance for Niger Delta bottom-water-drive reservoirs, generated through Monte Carlo propagation of hole-skin, critical-rate, breakthrough-time and discounted-cash-flow correlations, requires thousands of nested correlation evaluations per scenario impractical for time-constrained wellsite decisions during perforating or workover operations. This study develops and validates a machine-learning surrogate reproducing such Monte Carlo-derived outputs at near-instant speed. A synthetic training dataset of 10,000 design scenarios was generated across a fourteen-parameter reservoir, completion-design and economic feature space, with 1,000 inner Monte Carlo draws per scenario used to extract P10/P50/P90 targets. Three candidate architectures gradient-boosted trees, random forest and a shallow neural network were trained and compared on an 80/20 train-test split. The neural network achieved the highest accuracy (mean R^2 = 0.995 across all nine targets), exceeding a pre-specified R^2 > 0.9 target, while gradient-boosted trees and random forest achieved mean R^2 of 0.988 and 0.954. Benchmarked against a realistic per-iteration re-simulation of the inner Monte Carlo loop, the neural-network surrogate achieved a 2,026× speed-up, exceeding a three-orders-of-magnitude target. An explicit out-of-domain validity test showed accuracy degrading sharply, and in some cases catastrophically, for inputs sampled beyond the training range, defining the surrogate's valid domain of applicability. These results establish a trained neural-network surrogate as an accurate, dramatically faster substitute for full Monte Carlo re-simulation, offering completion engineers a practical, near-instant, risk-adjusted decision-support tool.

Keywords: *Machine learning; Surrogate modelling; Monte Carlo simulation; Completion design; Risk-based decision-making; Niger Delta*

Subtheme 8: Biomedical Engineering

Machine learning for early disease detection; wearable biosensors; ECG/EEG analysis; non-invasive BCIs.

Paper	Title	Presenter	Session and time	Page
CMT-09	Design of an AI-Driven Clinical Decision Support Framework for Personalized Kidney Disease Management	Abiodun Sojobi	TS1B, Wed 18 Nov, 2:30 pm, Room B (IMS)	78
CMT-21	Development of a Soft Wearable Hand Rehabilitation Robot Using Embedded Stretchable Sensors and Predictive Control for Adaptive Assistance	Zainab Bakare	TS1B, Wed 18 Nov, 2:50 pm, Room B (IMS)	79
CMT-23	AI-Enabled Low-Cost Wearable and Home Health Monitoring with Real-Time Anomaly Detection and SMS-Based Emergency Alerting for Rural Communities	Oluwapelumi Bada	TS1B, Wed 18 Nov, 3:10 pm, Room B (IMS)	80
CMT-29	Low-Cost Wearable Footstep Monitoring Device	Ayodeji Odufuwa	TS1B, Wed 18 Nov, 3:30 pm, Room B (IMS)	81
CMT-33	Can Routine Demographic and Lifestyle Data Predict Late-Stage Pancreatic Cancer? A Machine Learning Evaluation for Low-Resource Settings	Sunny Agbai	TS1B, Wed 18 Nov, 3:50 pm, Room B (IMS)	82
E-73	An Integrated Analytical Framework for Calcium Dependent MC4R Function	O. A. Gbenle	TS1B, Wed 18 Nov, 4:10 pm, Room B (IMS)	83
E-31	Electrospun Cellulose Acetate/ZnO Nanocomposite Membrane for Advanced Antimicrobial Wound Dressings	Jennifer C. Onwuasor	TS2B, Thu 19 Nov, 12:00 pm, Room B (IMS)	84
E-32	Real-Time Pressure and Compliance Monitoring in Post-Traumatic Orthotic Rehabilitation Using Edge Computing	Precious Parovien	TS2B, Thu 19 Nov, 12:20 pm, Room B (IMS)	85
E-33	UroScan: Design and Implementation of a Low-Cost Computer-Vision-Based System for Automated DUS-10 Urine Dipstick Analysis	David C. Oriaku	TS2B, Thu 19 Nov, 12:40 pm, Room B (IMS)	86
E-35	Mobile Application Integrated Wearable Cuffless Blood Pressure and Vital Signs Monitoring System	Emmanuel Olasunkanmi Igbemo	TS2B, Thu 19 Nov, 1:00 pm, Room B (IMS)	87
E-36	Smart Early-Warning Wearable System for Ear Health Monitoring (Headset-Integrated Edition)	Ayomide Henry Kolawole	TS3B, Thu 19 Nov, 2:30 pm, Room B (IMS)	88
E-44	Venosock: A Smart Compression Sock-Based Early Warning System for Deep Vein Thrombosis Risk Monitoring	Anuoluwaposiwa E. Ogunjimi	TS3B, Thu 19 Nov, 2:50 pm, Room B (IMS)	89
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E-46	RadTrack V1: Development of a Low-Cost Photodiode-Based Detection and Alarm Prototype for Diagnostic X-Ray Environments	Emeka B. Odiwe	TS4B, Thu 19 Nov, 4:00 pm, Room B (IMS)	91
E-62	Quantitative EEG Characterization of Neural Alterations Associated with Environmental Heat Exposure in Urban Heat Island (UHI): A Timestamp-Linked Hospital Archive Study	Ephraim O. Nwoye	TS4B, Thu 19 Nov, 4:20 pm, Room B (IMS)	92

CMT-09 | Biomedical Engineering
Technical Session 1B • Wednesday 18 November 2026 • 2:30 pm – 2:50 pm • Room B (IMS) • In person

CMT-09 Design of an AI-Driven Clinical Decision Support Framework for Personalized Kidney Disease Management

Abiodun Sojobi*

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Abstract

Chronic kidney disease (CKD) management requires decisions across several interconnected areas, including disease progression, medication use, treatment safety, clinical evidence, and lifestyle-related interventions. However, these sources of information are often considered separately, making it difficult to develop a unified and patient-specific approach to clinical decision support. This work presents the design of an AI-driven clinical decision support framework for personalized kidney disease management. The framework brings together multiple analytical components, including CKD progression prediction, analysis of medication utilization and polypharmacy, causal evaluation of treatment effects using observational health data, automated medication safety auditing based on clinical guidelines, retrieval of relevant clinical evidence, knowledge-based analysis of drug interactions, and personalized consideration of diet and lifestyle interventions. Rather than replacing clinical judgement, the proposed framework is intended to support clinicians by organizing patient-specific information and evidence into a structured decision-support process. The architecture is informed by a series of ongoing and completed computational studies using real-world clinical data, with individual components addressing different aspects of CKD management. The work highlights the potential value of integrating predictive modelling, causal inference, clinical rules, evidence retrieval, and knowledge representation within a single decision-support framework. Further research is required to evaluate the system in clinical settings and to establish its safety, validity, and usefulness for patient care.

Keywords: *Chronic kidney disease; artificial intelligence; clinical decision support; personalized medicine; causal inference; biomedical informatics*

CMT-21 | Biomedical Engineering
Technical Session 1B • Wednesday 18 November 2026 • 2:50 pm – 3:10 pm • Room B (IMS) • In person

CMT-21 Development of a Soft Wearable Hand Rehabilitation Robot Using Embedded Stretchable Sensors and Predictive Control for Adaptive Assistance

Zainab Bakare*

University of Lagos

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Abstract

One in seven people worldwide will have a stroke in their lifetime, and many who survive lose fine control of their hands. Recovery depends on repetition: hundreds of guided squeezes, done consistently, over weeks. Most patients never get that. Therapy stays clinic-bound, and in Nigeria a single therapist may be responsible for around 1,500 patients. This study asks whether a cheaper alternative can still work. Rather than build a soft actuator from scratch, an existing pneumatic hand-therapy glove was retrofitted with a rebuilt control system: one flex sensor, a low-cost microcontroller, and a predictive-trigger algorithm in place of the continuously-adjustable optimisation that full model-predictive control would normally demand, since the hardware only switches on or off. The controller watches a squeeze rise, fits it to a simple first-order curve, and fires assistance before the movement finishes rather than after. Across 117 real repetitions on a benchtop prototype, that curve matched the actual sensor data closely (R2 = 0.94-0.96). The predictive trigger fired in 28.2% of repetitions overall, and its firing rate rose from 0% near the sensor's noise floor to 52.9% at higher thresholds, precisely the pattern the underlying model predicts. A gap between the deployed time constant and one refitted independently from session data was found and reported as-is, not smoothed over. The result is a working case for low-cost, sensor-driven rehabilitation hardware as a genuine option for regions where the custom-built alternative was never going to be affordable.

Keywords: *assistive robotics; assist-as-needed therapy; flex sensor; stroke recovery; healthcare acces-*

CMT-23 | Biomedical Engineering
Technical Session 1B • Wednesday 18 November 2026 • 3:10 pm – 3:30 pm • Room B (IMS) • Online

CMT-23 AI-Enabled Low-Cost Wearable and Home Health Monitoring with Real-Time Anomaly Detection and SMS-Based Emergency Alerting for Rural Communities

Oluwapelumi Bada*, John Ogbemhe

University of Lagos

*Corresponding author: Oluwapelumi Bada • Presenting author: Oluwapelumi Bada (online)

Abstract

In low and middle-income countries, rural areas remain disproportionately affected by preventable morbidity due to the lack of continuous health monitoring capability in rural areas, which are not able to support broadband and cloud infrastructure. This project is designing, prototyping, and evaluating a two-tier low-cost wearable and home-gateway monitoring platform that maintains all monitoring steps locally on site, and reports via the second-generation cellular network that already covers most remote villages. The wearable node processes the photoplethysmography, blood oxygen saturation, skin temperature and inertial motion signals at up to 100 Hz on an ESP32-S3 microcontroller, performs a fourth order Butterworth filter and a normalised least mean squares adaptive stage, and conducts a Mahalanobis anomaly check against a personal baseline stored in flash, which is updated using a Welford algorithm. Feature packets are sent over Bluetooth Low Energy to a Raspberry Pi Zero 2W gateway to which a fully int8-quantised one-dimensional convolutional autoencoder is attached that scores 288-bin tensors for the day against a threshold set to the 99th percentile of validation error. The deployed 18 KiB model achieved a perfect recall on all controlled anomaly windows in the held-out set, and the 4.2 KiB autoencoder trained on real physiological recordings from 22 participants raised no false alarms on four locked-out subjects, suggesting the model is very robust. The total cost of electronics remains less than half a hundred US dollars, and provides a robust, off-the-grid solution to expanding equitable access to sustained physiological monitoring in remote rural communities. Keywords: edge computing, embedded machine learning, TinyML, convolutional autoencoder, photoplethysmography, store and forward messaging.

Keywords: *TinyML; edge computing; wearable health monitoring; anomaly detection; GSM emer-*

CMT-29 | Biomedical Engineering
Technical Session 1B • Wednesday 18 November 2026 • 3:30 pm – 3:50 pm • Room B (IMS) • In person

CMT-29 Low-Cost Wearable Footstep Monitoring Device

Ayodeji Odufuwa*, Mueez Sulaimon, AbdulMalik Alayande, Sulaimon Aibuku

University of Lagos

*Corresponding author: Ayodeji Odufuwa • Presenting author: Ayodeji Odufuwa

Abstract

Regular footstepsmoitoring devices have beenknown to require handheld devices to track footsteps.while this does not seem accurate enough for various reasons. This study aims to design and validate a low-cost, insole-embedded wearable device capable of continuously monitoring actual footstep patterns and gait symmetry, and fall risk indicators in real time. The prototype integrates an array of thin-film force-sensitive resistors with a six-axis inertial measurement unit (IMU) embedded in a shoe insole, connected to a low-power microcontroller with Bluetooth Low Energy transmission to a companion mobile application. Step count, stride time, plantar pressure distribution, and gait asymmetry were measured across 30 participants, including healthy adults and individuals with mobility impairment, and validated against a laboratory-grade force-plate and motion-capture system. The device is projected to achieve step-detection accuracy above 97%, gait asymmetry measurement within 5% of the reference system, and reliable identification of high-risk gait events such as shuffling or foot-drag with over 90% sensitivity, at an estimated unit cost under ₦20,000.00. These findings would demonstrate that affordable, continuous footstep monitoring can support remote rehabilitation tracking, contributing to more resilient, accessible healthcare infrastructure for fitness and mobility-impaired populations in resource-constrained settings.

Keywords: *wearable biosensors; footsteps; IoT; inertial measurement unit; steps monitoring*

CMT-33 | Biomedical Engineering
Technical Session 1B • Wednesday 18 November 2026 • 3:50 pm – 4:10 pm • Room B (IMS) • In person

CMT-33 Can Routine Demographic and Lifestyle Data Predict Late-Stage Pancreatic Cancer? A Machine Learning Evaluation for Low-Resource Settings

Sunny Agbai*

University of Lagos

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Abstract

Pancreatic ductal adenocarcinoma (PDAC) is usually diagnosed late, and stage at diagnosis largely determines whether a patient receives curative-intent adjuvant chemotherapy or palliative chemotherapy, leading to preventable deaths. In low-resource health systems with limited use of laboratory and imaging biomarkers for diagnosis of PDAC, there is a need to evaluate the efficacy of demographic and lifestyle data for PDAC diagnosis. This study evaluated whether demographic, lifestyle, and symptom variables can predict late-stage (Stage III/IV) presentation. A public, de-identified dataset of 49,913 patients with 38 candidate predictors and no missing values was analysed. Features were screened with point-biserial correlation, penalised regression and recursive feature elimination. Logistic Regression, Random Forest and XGBoost were tuned by cross-validated randomised search, evaluated with nested cross-validation and a 25% held-out test set (n = 12,479), and interpreted with SHapley Additive exPlanations (SHAP) and permutation importance. All three models performed at chance level on the test set (area under the receiver operating characteristic curve, 0.500–0.507; nested cross-validation, 0.497–0.498). No feature correlated with the outcome above a correlation coefficient of 0.01, and both interpretation methods showed negligible feature influence. Because the data are likely synthetic and contain no laboratory biomarkers, the result is evidence consistent with, rather than proof of, the insufficiency of demographic variables for stage prediction. For resilient health-system infrastructure, the findings favor investing first in structured capture of inexpensive laboratory and performance-status data before deploying predictive models.

Keywords: *Chemotherapy; Clinical Decision Support; Explainable Artificial Intelligence; SHAP*

E-73 | Biomedical Engineering
Technical Session 1B • Wednesday 18 November 2026 • 4:10 pm – 4:30 pm • Room B (IMS) • In person

E-73 An Integrated Analytical Framework for Calcium Dependent MC4R Function

O. A. Gbenle*, O. T. Talabi, A. J. Adeoti, D. O. Fawole

Department of Biomedical Engineering, Faculty of Engineering; Department of Biochemistry, Faculty of Life Sciences, University of Lagos

*Corresponding author: O. A. Gbenle • Presenting author: O. A. Gbenle

Abstract

Calcium participates in ligand recognition by the melanocortin-4 receptor (MC4R), providing a basis for integrating biochemical measurements with molecular modelling. This paper develops an analytical framework from an undergraduate research dataset comprising 50 calcium summary records, an eight-condition receptor comparison table and synthetic computational demonstrations. Descriptive statistics and Pearson correlations were recalculated from the calcium records; receptor comparisons and computational test summaries were interpreted according to their evidence status. Mean resting and peak calcium concentrations were 96.6 ± 14.0 and 305.9 ± 55.7 nM, respectively. BMI was weakly associated with resting calcium ($r = 0.027$, $p = 0.855$) and peak calcium ($r = 0.127$, $p = 0.380$). The receptor table described a 37.5-fold higher binding parameter under calcium depletion, but its assay provenance and uncertainty definitions were unresolved. Synthetic coordinate tests illustrated increasing RMSD and RMSF across prescribed perturbation scenarios and demonstrated distance-threshold calculations. These tests were methodological demonstrations, not MC4R molecular-dynamics trajectories. The framework separates extracellular calcium coordination, intracellular responses and computational verification, thereby identifying the measurements and records required for an experimentally traceable structure–function investigation. Its contribution is a structured analytical workflow; the available evidence does not establish variant-specific clinical effects or validated binding free energies.

Keywords: *melanocortin-4 receptor; calcium; bioinformatics; intracellular signalling; molecular modelling; analytical verification*

E-31 | Biomedical Engineering
Technical Session 2B • Thursday 19 November 2026 • 12:00 pm – 12:20 pm • Room B (IMS) • In person

E-31 Electrospun Cellulose Acetate/ZnO Nanocomposite Membrane for Advanced Antimicrobial Wound Dressings

Ugochi C. Uregbulam*, Jennifer C. Onwuasor, Azeez O. Yusuf, Ifesinachukwu R. Obidegwu, Ihuoma V. Diwe

Department of Biomedical Engineering, University of Lagos

*Corresponding author: Ugochi C. Uregbulam • Presenting author: Jennifer C. Onwuasor

Abstract

The cost of utilizing coaxial electrospinning is high, particularly in low resource settings. Electrospinning is a fabrication process that utilizes electric forces to draw out fibres from a polymeric solution. Single-nozzle electrospinning involves a single syringe and needle which are used to eject fibres from the solution. For advanced applications of cellulose acetate (CA) and zinc oxide (ZnO) fibres such as wound dressing, coaxial electrospinning is recommended. This study explores the single-nozzle electrospinning process as an alternative platform for the fabrication of compatible biomaterials suitable for antimicrobial wound dressings based on CA nanocomposites. The fabrication process required the incorporation of ZnO in minute quantities, into the CA solution to improve the properties of the resulting biomaterial. The solvents utilized were Acetone and DiMethyl Formamide (DMF) in the ratio 2:1 respectively. Upon testing of the resulting fibres, the CA fibre with ZnO additives had a higher maximum tensile stress of 0.23891MPa compared to the 0.11123MPa recorded by the pure sample. Also, it showed a 57-percentage-point higher water weight gain than the pure sample after an hour. Additionally, the incorporation of zinc oxide into the scaffold showed no significant effect on its thermal stability. Small inhibitory antibacterial activity was observed for both samples against the Enterobacter spp. isolate. However, further testing is recommended due to variations between replicates. These findings demonstrate that the single-nozzle electrospinning approach with fixed machine parameters was successful for multifunctional cellulose acetate nanocomposites for wound dressing and other biomedical applications.

Keywords: *biomaterials; characterization; electrospinning; nanocomposites; single-nozzle*

E-32 | Biomedical Engineering
Technical Session 2B • Thursday 19 November 2026 • 12:20 pm – 12:40 pm • Room B (IMS) • In person

E-32 Real-Time Pressure and Compliance Monitoring in Post-Traumatic Orthotic Rehabilitation Using Edge Computing

Ugochi C. Uregbulam*, Precious Parovien, Oreoluwa A. Kalejaiye, Damilola V. Alonge, Ephraim O. Nwoye

Department of Biomedical Engineering, University of Lagos

*Corresponding author: Ugochi C. Uregbulam • Presenting author: Precious Parovien

Abstract

Patients recovering from lower-limb trauma at LUTH usually wear rigid orthoses for weeks, and there are two risks involved: Pressure at high-risk sites such as the fibular head that can damage tissue and lead to peroneal nerve palsy or foot drop and poor compliance due to discomfort. These problems make bone healing and joint recovery slower, and add to hospital costs. This research presents the development of a low-cost Ortho-Monitorizer for real-time monitoring of orthoses. The device uses an ESP8266 12-E microcontroller to read data from a Force-Sensitive Resistor (FSR) to track mechanical pressure, MPU6050 Inertial Measurement Unit (IMU) to track wear-time movement, triggers audible alerts and displays a live dashboard via local WiFi for caregivers. It sets a personalized threshold after an initial one-hour learning phase. During bench testing, the device correctly changed from learning to alert mode, triggered the buzzer when pressure exceeded the personalized threshold for 30 continuous seconds, and served the live dashboard at a local IP address accessible without internet connectivity. This research paper contains details of system design, implementation and performance evaluation, and provides a foundation for further validation and development of affordable monitoring technologies.

Keywords: *Ankle-Foot Orthosis (AFO); ESP8266 microcontroller; Force-Sensitive Resistor (FSR); low-resource healthcare; peroneal nerve palsy*

E-33 | Biomedical Engineering
Technical Session 2B • Thursday 19 November 2026 • 12:40 pm – 1:00 pm • Room B (IMS) • In person

E-33 UroScan: Design and Implementation of a Low-Cost Computer-Vision-Based System for Automated DUS-10 Urine Dipstick Analysis

Ugochi C. Uregbulam*, David C. Oriaku, Oluwatimilehin E. Ayebo, Ayomide H. Adebisi, Isaac O. Omosuyi, Ephraim O. Nwoye

Department of Biomedical Engineering, University of Lagos

*Corresponding author: Ugochi C. Uregbulam • Presenting author: David C. Oriaku

Abstract

Urine Most clinics still use urine reagent strips which are read from a printed chart, requiring the reader to have vision and no digital record is kept. The aim of this study was to develop and test a self-made optical reader for a commercial 10-parameter strip (DUS 10 Home Test) in resource-poor environments. The reader was designed based on ESP32-CAM module, GC2145 image sensor, Organic light-emitting diode (OLED) display, buzzer, push button, and flash light-emitting diode (LED). A single wide frame would have left each pad too small so a guided workflow was used where the operator would bring one pad at a time forward. The mean red-green-blue (RGB) value of the central region of each frame was matched to reference colours, estimated from the manufacturer's chart, by Euclidean distance. A light-sealed enclosure has been designed, but not yet tested, which houses a toothed sliding carrier. There were 13 out of 20 pad captures received in 2 bench trials and 7 pad captures failed during wireless transfers. Of the 13 that did have frames, only 4 had RGB means within a reasonable range for an illuminated pad, and distances to the assigned reference colour ranged from 51 to 284 RGB units. Matching step running, but readings are not yet reliable, most likely due to uncontrolled lighting or exposure, and unstable wireless transfer. The next steps would be to complete the enclosure, lock exposure, process on the microcontroller and compare the results against samples of known composition. The project focuses on point of care diagnostic tools and low resource health technology, specifically urinalysis, colorimetry, embedded systems and ESP32-CAM.

Keywords: *urinalysis; point-of-care diagnostics; ESP32-CAM; colorimetry; embedded systems; low-resource health technology*

E-35 | Biomedical Engineering
Technical Session 2B • Thursday 19 November 2026 • 1:00 pm – 1:20 pm • Room B (IMS) • In person

E-35 Mobile Application Integrated Wearable Cuffless Blood Pressure and Vital Signs Monitoring System

Emmanuel Olasunkanmi Igbemo, Praise Ojonugwa Daniel, Ihuoma Vivian Diwe

[Affiliation to be confirmed by the authors]

Presenting author: Emmanuel Olasunkanmi Igbemo

Abstract

Existing cuffless blood pressure and wearable vital-sign solutions are often expensive, focus on isolated parameters, lack dietary sodium monitoring, and are poorly suited to resource-constrained settings with unreliable power supply. Hypertension remains a major public health challenge in Nigeria due to high dietary sodium intake and limited access to continuous monitoring tools. This project developed a low-cost, cuffless, wrist-worn wearable for continuous vital-sign monitoring. The system used an ESP32 microcontroller with photoplethysmography (PPG), electrocardiogram (ECG), motion, and skin-temperature sensors. Blood pressure was estimated using pulse transit time (PTT) from the ECG R-peak to PPG pulse arrival, calibrated against a standard sphygmomanometer, with a practical PPG-based fallback when ECG signals were unavailable. Heart rate and SpO_2 were obtained from PPG, while skin temperature was measured directly. Motion sensing helped identify movement that could affect signal quality. A Flutter mobile application communicated with the device through Bluetooth Low Energy (BLE) to display real-time and historical vitals, log sodium intake from common Nigerian foods, show trends, and generate simple alerts. Solar-assisted charging was included to support extended use in areas with unstable electricity. The prototype was tested against reference devices, including an Omron blood pressure monitor, pulse oximeter, and thermometer. Results showed acceptable performance for heart rate, SpO_2, temperature, and preliminary blood pressure estimation under controlled conditions. Future work includes larger validation studies and possible non-invasive glucose trend estimation using PPG.

Keywords: *Cuffless monitor; Mobile application; Photoplethysmography; Vital signs; Wearable device*

E-36 | Biomedical Engineering
Technical Session 3B • Thursday 19 November 2026 • 2:30 pm – 2:50 pm • Room B (IMS) • In person

E-36 Smart Early-Warning Wearable System for Ear Health Monitoring (Headset-Integrated Edition)

Ayomide Henry Kolawole, Ihuoma Vivian Diwe

[Affiliation to be confirmed by the authors]

Presenting author: Ayomide Henry Kolawole

Abstract

Many people suffer from ear infections, moisture buildup, irritation, or other types of ear problems, yet common medical instruments used to examine the ear are typically only available in hospitals or clinics. To address this gap, this study presents AuricleGuard, a simple, non-invasive smart headset that can be used every day for continuous ear-health monitoring. Previous studies have used clinic-based tools to detect ear problems, but they lack continuous monitoring and microclimate sensing. However, these methods are largely reactive and limited to point-in-time assessments. This study developed a smart headset that can monitor the ear-canal micro-environment and acoustic reflections in real time using low-intensity sound emission, Micro-Electro-Mechanical Systems (MEMS) echo detection, and temperature-humidity microsensors. The work included building the hardware, developing the software, testing the prototype, and comparing the results with normal ear-health measurements. These ultimately led to earlier detection of ear problems, better prevention, and easier access to personal ear-health monitoring. Therefore, AuricleGuard shows how an everyday wearable device can be improved to support simple health monitoring.

Keywords: *Ear-canal; microenvironment; microsensors; temperature–humidity; wearable device*

E-44 | Biomedical Engineering
Technical Session 3B • Thursday 19 November 2026 • 2:50 pm – 3:10 pm • Room B (IMS) • In person

E-44 Venosock: A Smart Compression Sock-Based Early Warning System for Deep Vein Thrombosis Risk Monitoring

Ugochi C. Uregbulam*, Anuoluwaposiwa E. Ogunjimi, Enioluwa O. Ojo, Zainab T. Adebayo, Israel A. Adebayo, Ephraim O. Nwoye

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*Corresponding author: Ugochi C. Uregbulam • Presenting author: Anuoluwaposiwa E. Ogunjimi

Abstract

Deep vein thrombosis (DVT) has a high risk of fatal Pulmonary Embolism if left unmonitored. In developing countries like Nigeria, standard clinical detection relies heavily on expensive, retroactive ultrasound imaging, which is often inaccessible until severe complications arise. To bridge this gap, we created Veno-Sock, a low-cost, multimodal wearable risk-warning system developed to proactively determine the probability of DVT. Rather than diagnosing an already-formed clot, the device continuously tracks early physiological risk indicators like localized geometric calf expansion, immobility, and thermal asymmetry to shift DVT management from delayed hospital imaging to accessible, early intervention. The prototype utilizes an ESP32 microcontroller integrated with four sensor modalities: a DS18B20 to measure skin temperature, a voltage-divider flex sensor to track calf expansion, an MPU6050 accelerometer to monitor immobility duration, and a MAX30102 to assess peripheral perfusion. An embedded rule-based algorithm processes these real-time data streams against a calibrated patient baseline, fusing the independent variables to compute an abnormality score. As a work-in-progress, ongoing performance evaluations are quantifying the system's accuracy. The prototype's architecture relies on high-fidelity localized data, utilizing thermal sensors with a verified operational accuracy of ±0.5°C and an MPU6050 accelerometer tracking immobility thresholds down to 0.1g variations. Preliminary validation confirms the system successfully integrates these 4 data streams to escalate through 3 distinct alert states (Low, Warning, High) with 0% false-positive triggers during baseline resting states. Ultimately, this scalable screening tool empowers at-risk individuals to seek timely clinical evaluation, preventing potentially fatal complications .

Keywords: *Deep Vein Thrombosis; Embedded Systems, Multimodal Wearable; Proactive Healthcare*

E-45 | Biomedical Engineering
Technical Session 3B • Thursday 19 November 2026 • 3:10 pm – 3:30 pm • Room B (IMS) • In person

E-45 NeoLightGuard: A Low-Cost Real-Time Irradiance Monitoring System for Neonatal Phototherapy

Ugochi C. Uregbulam*, Mayowa E. Titilola, Oluwakorede Adeniyi, Mosimiloluwa E. Aluko, Temitope D. Ojo, Ephraim O. Nwoye

Department of Biomedical Engineering, University of Lagos

*Corresponding author: Ugochi C. Uregbulam • Presenting author: Mayowa E. Titilola

Abstract

NeoLightGuard: A Low-Cost Real-Time Irradiance Monitoring System for Neonatal Phototherapy Mayowa E. Titilolaa, Oluwakorede Adeniyia, Mosimiloluwa E. Alukoa, Temitope D. Ojoa, Ugochi C. Uregbulama*, Ephraim O. Nwoyea a Department of Biomedical Engineering, Faculty of Engineering, University of Lagos, Nigeria Phototherapy is the primary treatment for neonatal jaundice, but its effectiveness depends on the irradiance actually delivered to the infant, which is rarely verified at the bedside. Surveys of phototherapy units in Nigeria and Indonesia found many delivering less than the 30 µW/cm²/nm recommended for intensive treatment, while commercial meters are costly. Published low-cost solutions have focused on calibration meters or lamp-integrated sensing, leaving multi-point monitoring of the treatment field largely unaddressed. This study developed NeoLightGuard, a low-cost optical monitoring system in which a photodiode and transimpedance amplifier convert incident blue light into a voltage that an ESP32 microcontroller digitises, filters and calibrates. The signal chain was characterised on the bench over two baseline runs of 23 samples each. Filtered analogue-to-digital converter (ADC) output ranged from 0.45 to 9.22 counts, giving calibrated voltages of 142–162 mV (run means 147.4 ± 6.5 and 146.0 ± 4.8 mV; coefficients of variation 4.4% and 3.3%), close to the lower limit of the converter's specified range. Against a reference radiometer at five positions of the treatment area, the absolute mean deviation was 1.12 µW/cm²/nm (43.0%), and 0% of sample points met or exceeded the 30 µW/cm²/nm threshold; spatial variation peaked at 4.27 µW/cm²/nm (94.9%). These figures show that the current transimpedance gain leaves weak signals too close to the ESP32 ADC bottom cutoff, so higher feedback resistance and level shifting are needed. NeoLightGuard shows that low-cost, localised monitoring of the treatment field is feasible, though recalibration and formal clinical validation remain prerequisites.

Keywords: *Neonatal phototherapy; Irradiance monitoring; Hyperbilirubinemia; ESP32; Real-time sensing*

E-46 | Biomedical Engineering
Technical Session 4B • Thursday 19 November 2026 • 4:00 pm – 4:20 pm • Room B (IMS) • In person

E-46 RadTrack V1: Development of a Low-Cost Photodiode-Based Detection and Alarm Prototype for Diagnostic X-Ray Environments

Ugochi C. Uregbulam*, Feyisayomi O. Olorode, Emeka B. Odiwe, Jessica C. Anichukwu, Emmanuel O. Isaac, Ephraim O. Nwoye

Department of Biomedical Engineering, University of Lagos

*Corresponding author: Ugochi C. Uregbulam • Presenting author: Emeka B. Odiwe

Abstract

In any environment in which diagnostic imaging and X-ray equipment are employed, radiation represents a significant concern. Even though radiation monitoring devices are available, their high cost and the possibility that they are not easily accessible can result in additional monitoring equipment not being used in some cases. This article presents RadTrack V1, a low-cost electronic prototype that detects a change in the sensor's response and activates a local audible and visual alarm. The prototype employs a BPW34 silicon PIN photodiode, an OPA350 transimpedance amplifier, an LM393 comparator and an ESP32 microcontroller, with a liquid-crystal display, light-emitting diodes and a buzzer for the local interface and alerts. It was built from readily available components and is housed in a 3D-printed case. When the photodiode was covered, the amplifier output was 0.20 V and rose to 1.00 V when it was exposed to light, a difference of 0.80 V. These results show that the device does respond to light under the test conditions, but they do not demonstrate that it has the required performance for detecting X-rays. The estimated cost of components and assembly was ₦60,450, which is 48.9% and 64.4% less than two commercially advertised radiation-monitoring listings; the comparison is based solely on listed prices and does not imply equal performance. RadTrack V1 is therefore described as an early-stage detection-and-alarm prototype, and controlled X-ray testing, threshold optimisation and calibration against a reference instrument are necessary before its suitability for use as a radiation monitor can be assessed.

Keywords: *BPW34 photodiode; electronic alarm; low-cost instrumentation; radiation safety; X-ray detection*

E-62 | Biomedical Engineering
Technical Session 4B • Thursday 19 November 2026 • 4:20 pm – 4:40 pm • Room B (IMS) • In person

E-62 Quantitative EEG Characterization of Neural Alterations Associated with Environmental Heat Exposure in Urban Heat Island (UHI): A Timestamp-Linked Hospital Archive Study

Chiemezie P. Jacob, Samuel O. Okodeh, Ephraim O. Nwoye*

Department of Biomedical Engineering, University of Lagos

*Corresponding author: Ephraim O. Nwoye • Presenting author: Ephraim O. Nwoye

Abstract

Environmental heat is associated with cognitive impairment and acute neurological illness, but objective evidence of heat-related changes in brain activity from routine clinical settings in sub-Saharan Africa is scarce. This study examined whether quantitative electroencephalogram (EEG) features are associated with ambient heat exposure in the clinical EEG archive of a tertiary hospital in Lagos, Nigeria. Because no patient identifier linked the EEG system to other hospital records, each recording was linked by its exam timestamp to hourly reanalysis-based temperature and heat index for the preceding 24 and 72 hours. Of 817 archived sessions, 626 (110,414 ten-second epochs) yielded eighteen spectral, nonlinear and time-domain outcomes, which were regressed on heat exposure using mixed-effects or cluster-robust models with Benjamini–Hochberg false discovery rate control. Permutation entropy, a measure of signal complexity, was negatively associated with 24-hour heat index (adjusted $p = 0.0298$), remained significant under all four exposure definitions ($p \leq 0.002$) and after adjustment for time of day and season ($p = 0.0017$), although the standardised effect was small (about −0.13 standard deviations per standard deviation of heat index). Classical slowing markers showed no association. A two-feature Thermal EEG Index generalised under a patient-grouped hold-out ($r = 0.210$, $p = 0.0182$) but not under a temporal hold-out ($r = −0.075$, $p = 0.404$) and is not considered validated. The findings identify permutation entropy as a candidate marker for prospective study of heat-related neurological effects in rapidly warming tropical cities.

Keywords: *electroencephalography; environmental heat exposure; permutation entropy; urban heat island; retrospective clinical archive*

Subtheme 9: Cross-Disciplines

Sustainable design, systems thinking and lifecycle optimisation; digital twins for infrastructure and Industry 5.0.

Paper	Title	Presenter	Session and time	Page
CMT-42	Deployment Analysis of a Context-Aware DeBERTa Sarcasm Detector: ONNX Export, INT8 Quantisation and CPU Latency	Deborah I. Adaramola	TS4A, Thu 19 Nov, 4:40 pm, Room A (IMS)	94
CMT-39	Engineering Innovations as Determinants of Sustainable Sports Infrastructure and Event Management Performance in Nigeria: A Comparison with Global Best Practices	Babajide Sewoniku	TS5B, Fri 20 Nov, 10:20 am, Room B (IMS)	95

CMT-42 | Cross-Disciplines
Technical Session 4A • Thursday 19 November 2026 • 4:40 pm – 5:00 pm • Room A (IMS) • Online

CMT-42 Deployment Analysis of a Context-Aware DeBERTa Sarcasm Detector: ONNX Export, INT8 Quantisation and CPU Latency

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Abstract

Context-aware sarcasm detectors are more accurate than utterance-only models but are expensive to run, and their deployment costs are rarely reported. We present a deployment study of C-STAR, a three-stream, 188.9-million-parameter sarcasm detector built on DeBERTa-v3-base (test Macro- F1 0.8025). The trained model was exported to the Open Neural Network Exchange (ONNX) format, compressed with 8-bit integer (INT8) dynamic quantisation and benchmarked against PyTorch on a central processing unit (CPU) at batch size 1 (200 timed requests) against a target of 50 ms for the 99th-percentile (P99) latency. Contrary to the usual expectation, quantisation enlarged the model from 758.9 MB to 840.8 MB (+10.8%). Median latency fell from 1038.65 ms to 761.58 ms (1.36×), but P99 latency stayed above 1100 ms, more than 20 times the target. Graph inspection showed 480 Gather operations left in 32-bit floating-point (FP32) precision and 394 separate matrix multiplications from disentangled attention. Latency is dominated by re-encoding the target and each prior turn through the full backbone, five or six passes per prediction. A simple estimate suggests that caching turn encodings alone would still leave P99 several times above target, so distillation and static quantisation are also needed. Post-quantisation accuracy was not measured.

Keywords: *sarcasm detection; model deployment; post-training quantisation; ONNX; inference*

CMT-39 | Cross-Disciplines
Technical Session 5B • Friday 20 November 2026 • 10:20 am – 10:40 am • Room B (IMS) • Online

CMT-39 Engineering Innovations as Determinants of Sustainable Sports Infrastructure and Event Management Performance in Nigeria: A Comparison with Global Best Practices

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Abstract

In Nigeria's sports ecosystem, many public sports facilities at the federal and state levels are underused, poorly maintained, and break down within a few years of opening. This study looked at research concerning sports facilities and events in the six geopolitical zones of Nigeria to examine the impact of engineering innovations on the longevity of the infrastructure and on the results of the events. The authors conducted a qualitative, systematic narrative review in accordance with the PRISMA 2020 guidelines and analysed sixteen studies: fourteen focused on individual states and two on more than one zone. The findings have been compared with international standards such as those from London 2012, Qatar 2022, and the global sustainability criteria. Recurring problems include a lack of a proper maintenance culture, insufficient funding, and deficiencies in facility provision and standards. Only one study directly examined engineering innovation through technology adoption in tertiary institutions. The strongest links between engineering innovation and event outcomes appear in studies of the national sports festival, the youth games, and those examining value loss due to poor maintenance. The evidence differs from zone to zone, with the South-East in particular having a lack of recent data. This paper presents a zone-specific framework, showing how engineering innovation can enhance facility sustainability and event performance, and suggests tailored priorities for each region. The evidence shows that maintenance needs dedicated funding, that lifecycle planning must occur before introducing advanced technologies, and that engineering audits should be included in education sector surveys.

Keywords: *engineering innovation; event management; facility maintenance; geopolitical zones*

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