2nd International Conference on Engineering, Technology, and Applied Science Innovations

ICETASI 2026

2026, September 24-26, Zakynthos, Greece

Book of Abstracts



ΗΩΣ
ΠΟΛΙΤΙΣΤΙΚΟΣ ΣΥΛΛΟΓΟΣ

EOS
CULTURAL ASSOCIATION

ICETASI 2026

2nd International Conference on Engineering, Technology, and Applied Science Innovations

Organized by the EOS Association and the Department of Environment of the Ionian University.
Co-organized by the Helias Branch of the Hellenic Mathematical Society and the Municipality of Zakynthos.
Under the aegis of the Zakynthos Chamber of Commerce.

Book of Abstracts



EOS Association

Editors: Konstantinos Poirazidis and Gerasimos Pylarinos

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ICETASI

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ΙΝΝΙΑΣ Ο ΗΛΕΙΟΣ 2007

2nd International Conference on Engineering, Technology and Applied Science Innovations Zakynthos, Greece

24-26 September 2026

Department of Environment,
Ionian University (Zakynthos)

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Preface

It is our great pleasure to welcome you to the **Book of Abstracts of the 2nd International Conference on Engineering, Technology and Applied Science Innovations (ICETASI 2026)**. This volume contains the abstracts of all presented works, posters, and supplementary material that did not make it to the official proceedings that will be published shortly by ***Engineering Proceedings***, along with some photos. ICETASI 2026 was the second academic conference organized by the **EOS Association**, a non-profit organization established in Northwest Ileia, Greece. Having the Proceedings of ICETASI 2025 indexed in Scopus and moving the conference out of our home base posed two major challenges, which we believe were successfully overcome.

The primary objectives of ICETASI 2026 were to provide a prominent platform for showcasing cutting-edge advancements and addressing contemporary challenges in advanced sciences and technological innovation. Simultaneously, it aimed to provide a safe space for emerging researchers to exhibit their work, promote the high-quality research conducted in the **Department of Environment of the Ionian University**, showcase that Western Greece and the Ionian Islands are not only attractive tourist destinations but are also fully capable of hosting major international scientific events, and engage the local community while presenting top-level academic research.

We are delighted to report that ICETASI 2026 concluded in absolute success, gathering researchers, academics, industry professionals, and decision-makers, fostering vibrant discussions and multidisciplinary collaborations.

The success of a conference depends on the dedication and hard work of many individuals. We would like to express our gratitude to the members of the Scientific, Technical, and Organizing Committees for their meticulous planning and coordination. We extend our sincere thanks to our distinguished keynote speakers for their inspiring presentations, and to the session chairs for keeping the program strictly on schedule while maintaining a high level of academic discourse.

We deeply thank the Department of Environment of the Ionian University for hosting and co-organizing the event, the Municipality of Zakynthos and the Zakynthos Chamber of Commerce for their help and cooperation, the Helias Branch of the Hellenic Mathematical Society for the successful organization of the "Applied Sciences & Digital Innovation in Secondary Education" Workshop and the overall help in the organizing sector, and, most importantly, we are grateful to all the authors and presenters who shared their valuable research. We would also like to thank our sponsors, especially the Xenos Hotel Group for the flawless hospitality.

We look forward to seeing you at the next ICETASI!

For the Organizing Committee of ICETASI 2026,

Konstantinos Poirazidis, Dean, School of Environment, Professor of Spatial Ecology and Conservation and Director of the Laboratory of Environmental Management and Sustainable Development, Department of Environment, Ionian University, Greece

Gerasimos Pylarinos, Chair, EOS Association, Greece


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ICETASI logos designed by Ioannis Konstandinidis. Posters designed by Nikos Dionysopoulos and Gerasimos Pylarinos.

Welcoming Address

Distinguished representatives of the academic and research community,

Dear professors and researchers,

Dear delegates and participants,

Ladies and gentlemen,

It is with great pleasure and honour that I welcome you to Zakynthos and to the 2nd International Conference on Engineering, Technology and Applied Sciences, ICETASI 2026. As Mayor of Zakynthos, I would like to warmly thank you for choosing our island as a meeting place for scientific knowledge, research, innovation and international cooperation. Your presence here is of particular importance to us.

Zakynthos is a vibrant place that faces complex challenges every day and seeks modern, evidence-based and sustainable solutions. And it is precisely here that the objectives of this conference meet the needs of our island. The sustainable management of water and waste, the protection of the natural environment, addressing the impacts of tourism development, energy efficiency, the circular economy, smart cities, digital technologies and artificial intelligence are no longer merely theoretical discussions. They are issues that directly affect the daily lives of our citizens and the future of island communities. The major challenge for local government is to transform knowledge and innovation into practical solutions that deliver measurable benefits for citizens. It is about achieving a balance between development, economic activity, the quality of life of our residents, and the protection of our natural and cultural heritage.

For a place like Zakynthos, this balance is absolutely critical. Tourism is a key pillar of our local economy. At the same time, however, we must ensure that tourism development does not come at the expense of our environment, our cultural identity or the daily lives of our residents. We want a Zakynthos that will grow, but will grow with a plan.

A Zakynthos that will protect its natural environment, showcase its cultural heritage, and at the same time create new opportunities for its residents and for the younger generation. In this effort, cooperation with universities, research institutions and the scientific community is essential. The presence of the Department of Environment of the Ionian University in Zakynthos is a significant asset for our island. Connecting academic knowledge with the real needs of society can create a valuable ecosystem of knowledge, innovation and development.

I would therefore like to warmly congratulate the EOS Cultural Association, the Department of Environment of the Ionian University, the Ilia Branch of the Hellenic Mathematical Society, and all the partner institutions for organising ICETASI 2026.

The Municipality of Zakynthos is particularly proud to support this important international scientific gathering and to participate actively in its proceedings.

I would also like to extend a warm welcome to all the scientists and researchers who have travelled to Zakynthos from Greece and abroad. I wish you creative and productive conference proceedings, leading to new collaborations, new ideas and, above all, to solutions that can be put into practice. I also hope that your stay in Zakynthos will give you the opportunity not only to exchange knowledge and experience, but also to discover our island more closely—its history, its culture and its people. I wish you every success in the proceedings of ICETASI 2026, and I hope you have a pleasant and inspiring stay on our island.

Thank you very much.

George Stasinopoulos

Mayor of Zakynthos

Opening Statement by the Organizing Committee

President of the Department of Environment, Dean of the Department, Dear Mayor

Distinguished guests, dear colleagues, researchers, academics, students, and friends,

It is a great pleasure and a great honor, on behalf of the EOS Association, to welcome you to the 2nd International Conference on Engineering, Technology and Applied Science Innovations — ICETASI 2026.

Welcome to Zakynthos, welcome to the Ionian University, and most importantly, welcome to a meeting of people who share a common interest in knowledge, innovation, technology, and in finding solutions to the challenges of our time.

Before anything else, I would like to express our sincere gratitude to all those who have made this conference possible.

As you may know, a conference like ICETASI is never the work of one person or one organization. It is the result of a collective effort, and we are grateful to everyone who has contributed to it.

Our warmest thanks go to the other organizer of the event, the Department of Environment of the Ionian University.

We also thank the Municipality of Zakynthos and the Zakynthos Chamber of Commerce for their valuable contribution.

The Association would also like to thank the Helias Branch of the Hellenic Mathematical Society for organizing the Applied Sciences & Digital Innovation in Secondary Education Workshop, in an effort to bridge top-level research outcomes with everyday school experience

Our sincere appreciation also goes to our sponsors and supporting organizations:

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- Oranon Kaparelis
- Karkavelias Agricultural Machinery

We also thank the members of the Scientific, Organizing and Technical Committees, all our reviewers and volunteers, and of course, our invited and plenary speakers, the authors, and the participants.

Let me now say a few words about who we are.

The EOS Association is a non-profit organization with a strong interest in bringing people, knowledge, and ideas together.

For us, organizing an event such as ICETASI is not simply about creating another conference.

Our goals were to:

- Create a space where researchers can meet the industry, where different disciplines can communicate, where experience can be exchanged, and where scientific knowledge can move beyond the boundaries of a single laboratory, university, or field.
- Promote and disseminate the high-quality research conducted within the Department of Environment at the Ionian University to a broader audience.
- Showcase that Western Greece and the Ionian Islands are not only attractive tourist destinations, but can also be vibrant academic and research hubs, capable of hosting major international scientific events.
- Engage the local community and present top-level academic research to the public

So far, these goals have been achieved, with researchers from various countries and universities presenting their work and trusting our review pipeline, the Ionian University has played a major part in the academic process and is presenting a large part of the research conducted in these facilities, and major local actors have embraced the event actively.

For us, ICETASI is more than a conference acronym.

It is a platform for interdisciplinary collaboration, and this diversity is one of its greatest strengths.

Because the challenges we, as a society, face today do not belong to one scientific discipline.

Climate change, sustainable development, energy transition, water and waste management, digital transformation, artificial intelligence, new materials, and the responsible use of technology require us to think across disciplines.

We are also particularly pleased that ICETASI provides "a safe" space for emerging researchers.

Over the next days, I encourage you not only to attend the scientific sessions, but also to talk to one another.

Meet someone whose research is outside your own field.

Ask questions.

Share an idea.

Start a conversation.

Find common ground.

Because perhaps the most valuable outcome of a conference is not always the paper we present or the lecture we attend, but the connection we make with another person.

Once again, on behalf of the EOS Association and the entire ICETASI 2026 organizing team, I would like to thank you for being here and for contributing your knowledge, your time, and your enthusiasm.

We hope that these three days will be scientifically productive, personally rewarding, and that you will also have the opportunity to experience the hospitality and beauty of Zakynthos.

It is our great pleasure to welcome you to ICETASI 2026.

I wish you all a successful conference, fruitful discussions, new collaborations, and an inspiring experience.

Thank you, and welcome to ICETASI 2026.

Maria Thanopoulou

Board Member, EOS Association

ICETASI 2026 SCHEDULE

Thursday, September 24, 2026

TIME	ROOM A (MAIN HALL)
10:00-11:00	**Installations**
11:00-12:00	**Smart Cities, Urban Environment, and Digital Applications** **Chairs: K. Poirazidis, A. Martinis, G. Stavridis** • **Stylianos Palladinos**, Department of Environment, Ionian University, Greece: **GIS-Based Multicriteria Assessment and Spatial Mapping of Urban Quality of Life: The Case of Zakynthos, Greece** *Authors: Stylianos Palladinos, Katerina Kabassi, Pantelis S. Apostolopoulos, and Konstantinos Poirazidis* • **Georgios Kefalas**, Department of Environment, Ionian University, Zakynthos, Greece: **Urban Landscape Configuration and Seasonal Land Surface Temperature in Metropolitan Athens** *Authors: Georgios Samoilis, Georgios Kefalas, and Konstantinos Poirazidis* • **Ioannis Konstantinidis**, Independent Researcher, Greece: **Hierarchical Bayesian Spatial Framework for Air Quality Imputation in Sparse Sensor Networks** *Authors: Ioannis Konstantinidis and Gerasimos Pylarinos*
12:00-12:30	**Coffee Break**
12:30-13:15	• **Plenary: K. Kabassi**, Department of Environment, Ionian University, Greece: **From Theory to Impact: Multi-Criteria Decision Making as an Engine for Applied Innovation in Sustainability and Cultural Heritage (45')**
13:15-17:00	**Free time**
17:00-18:00	**Geoinformatics in Agriculture and Ecosystem Management** **Chairs: K. Poirazidis, G. Lykokanellos, G. Stavridis** • **Georgios Stavridis**, Laboratory of Environmental Management and Sustainable Development, Department of Environment, Ionian University, Greece: **From Meteorological Recovery to Soil-Water Persistence: A Native-Grid Multiscale Drought Framework for the Ionian Islands, Greece (1981-2024)** *Authors: Georgios Stavridis, Konstantinos Poirazidis, Pantelis Apostolopoulos, and Panteleimon Xofis* • **Georgios Lykokanellos**, Department of Agriculture, University of Patras, Greece: **An Integrated Sustainable Floriculture Model Combining Soilless Propagation Systems, Auxin Optimization and Indus-try 4.0 Automation** *Authors: Georgios Lykokanellos, Aglaia Liopa-Tsakalidi, and Vasileios Thomopoulos* • **Myron Skandalakis**, Department of Environment, Ionian University, Greece: **Diachronic Assessment of the**

	Suitability of Bee Habitats within the Natura 2000 Areas of Crete *Authors: Myron Skandalakis, Konstantinos Poirazidis, Katerina Kabassi and Aristotelis Martinis* • **Konstantinos Asiklaris**, Department of Environment, Ionian University, Greece: **Computer Vision – Based Approach for Estimating Dimensions of Olive Trees** *Authors: Konstantinos Asiklaris, Katerina Kabassi, and Aristotelis Martinis*	
18:00-18:15	**Coffee Break**	
18:15-19:00	**Welcome Session**	
19:00-19:15	**Break**	
TIME	**ROOM A (MAIN HALL)**	**ROOM B (HALL 1)**
19:15-20:15	**AI in Education & STEAM Track 1 - Artificial Intelligence and Digital Innovations in Education and Interactive Systems** **Chairs: K. Kabassi, K. Antonopoulos, G. Pylarinos** • **Dionisios Zougras**, Department of Environment, Ionian University Zakynthos, Greece: **Exploiting Teachers' Proficiency in Harnessing Artificial Intelligence for Physical Education** *Authors: Dionisios Zougras, Ilias Flabouras Nietos, and Katerina Kabassi* • **Ramazan Ertuğrul Aydoğan**, Department of Communication and Computer Engineering, Faculty of Engineering, South West University "Neofit Rilski", Bulgaria | Gaziantep University, Gaziantep, Türkiye: **Facial Identification and Attendance Infrastructure for Adaptive Smart Classrooms: An Edge Prototype and Open-Set Benchmark** *Authors: Ramazan Ertuğrul Aydoğan, Fatima Sapundzhi, Berat Çiftçi, Öykü Boğazkesenli, and Slavi Georgiev* • **Hristo Ivanov**, Department of Computer Science, Varna Free University "Chernorizets Hrabar", Bulgaria: **A framework for interactive visualization and Evaluation of Classical Shortest-Path Algorithms in a Grid-Based Game** *Authors: Hristo Ivanov, Fatima Sapundzhi, Antonina Ivanova, and Meglena Lazarova* • **Konstantinos Chrysanthos Sofianos**, Department of Informatics, Ionian University, Greece: **A Results-Based Evaluation Framework for Smart Learning Environments: Use Cases, User Testing, and Validation Design of the OSEME Platform** *Authors: Konstantinos Chrysanthos Sofianos, Michael Stefanidakis, Manolis Maragoudakis, Alexios Kaponis, and Linas Bukauskas*	**HMS, Branch of Helias, Workshop Session 1** **Chairs: A. Papadopoulos, S. Mpaleli, A. Kapatou** • **G. Christopoulou: Exploring Geometric and Topological Models through 3D Printing: Utilizing Holden and Escher 3D Models in a School STEAM Group** **Στρογγυλό τραπέζι : Η θέση των Μαθηματικών στο σύγχρονο τοπίο της εκπαίδευσης (Panel Discussion: The place of Mathematics in the modern landscape of education - in Greek)** **Moderator: A. Kalampoka**

Friday, September 25, 2026

TIME	ROOM A (MAIN HALL)
09:00-15:00	**Optional Excursion: Zakynthos day tour: Bochali – Agios Nikolaos – Shipwreck beach, Blue caves – Anafonitria – Therianos Family Farm – 6 hrs €25**
09:45-11:00	**Emerging Technologies and Applied Innovations in Modern Infrastructure** **Chairs: C. Antonopoulos, K. Antonopoulos, E. Merkoulidi** • **N. Kottis**, Department of Computer Engineering and Informatics, University of Patras | Vice Mayor of Development Planning & European Programs of the Municipality of Zakynthos: **Sustainable Tourism Development and Local Cultural Identity: Challenges and Prospects for Safeguarding Cultural Heritage and Protecting the Natural Environment in Areas Experiencing Rapid Tourism Growth** • **C. Antonopoulos**, ECE Department, University of Peloponnese, Patras, Greece: **Low-Cost BLE AoA Exploration Capabilities Leveraging Statistical Analysis of RSSI and I/Q Features** *Authors: Georgios Tsikelis, Konstantinos Antonopoulos, Christos Antonopoulos and Nikolaos Voros* • **Eleftheria Merkoulidi**, Solar Energy Laboratory, Department of Physics, University of Patras, Greece: **Smart Windows for Energy-Efficient Buildings: From Electrochromic to Self-Powered Photo-electrochromic Technologies** *Authors: Eleftheria Merkoulidi and George Syrrokostas* • **Rami Ahmed Mohammed**, College of Electromechanical Engineering, University of Technology-Iraq, Baghdad, Iraq: **Simulation-Based Intelligent Multi-Aircraft Formation Navigation System Using PID Control and Particle Swarm Optimization Under Realistic Environmental Conditions** *Authors: Rami Ahmed Mohammed, Mohammed Qasim Sulttan, and Wisam Essmat Abdul-Lateef*
11:00-11:30	**Coffee Break – Poster Exhibition**

TIME	ROOM A (MAIN HALL)	ROOM B (HALL 1)
11:30-13:00	**Advanced Cyber-Physical Systems and Applied AI** **Chairs: P. Apostolopoulos, V. Thomopoulos, G. Pylarinos** • **Vasileios Thomopoulos**, Department of Computer Engineering and Informatics, University of Patras, Greece: **An Agent-Based Simulation of the Greek Electricity Market under Extreme Weather Scenarios** *Authors: Vasileios Thomopoulos, Georgios Stergiou, and Kostas Tsichlas* • **Dionysia Varvarigou**, University of Patras, Greece: **Edge-AI-Based Multi-Modal Soil Organic Matter Estimation Using RGB, Spectral, and Munsell Color Representations** *Authors: Mario Fahim, Dionysia Varvarigou, Aliki Panagiotarou, Pantelis Barouchas, and Paris Kitsos* • **Antonio T. Alexandridis**, Department of Electrical and Computer Engineering, University	**Applied Engineering and Sustainable Infrastructure** **Chairs: I. Konstantinidis, C. Priovolos, A. Kaponis** • **Rana Nezar Dawood**, University of Technology Mechanical Engineering College, Iraq: **Investigation of Natural Convection Heat Transfer in Two Vertical Heated Walls Partially Filled with Porous Media** *Authors: Rana Nezar Dawood, Ali L. Ekaid, and Nabeel Sameer Mahmoud* • **Mohammed Zainel Qader**, North Oil Company - Field Division - Department of Geology, Iraq: **Assessment of the Sulfate Attack Susceptibility of Cementitious Materials in Urban Development Areas of Northeastern and Southern Kirkuk, Iraq** *Authors: Zainel Qader, Junaid Fouad Kareem, Elaf Mohammed Shakir, Lizan Ahmed Saleh, Hiba Hasan Sultan, Hiyam Ali Fadhil, and Belen Ali Saeed* • **Klodjan Xhexhi**, Architecture and Engineering Department, Polis University, 1051 Tirana, Albania: **Recycled Composite Panels for Sustainable Interior Architecture: Density,**

	of Patras, Patras, Greece: **Nonlinear Modeling and Coordinated Control Strategies for Studying HVDC-connected RES/ESS to the Grid** *Authors: Nikolaos C. Psychalinos, Panos C. Papageorgiou, Theodosis A. Alexandridis, George C. Konstantopoulos, and Antonio T. Alexandridis* • **Agisilaos Kolliopoulos**, University of Patras, Greece: **Scenario-Based People-Process-Technology Mapping for Social Engineering Awareness** *Authors: Agisilaos Kolliopoulos, Dionysia Varvarigou, Kostas Lampropoulos, Spyros Denazis, and Paris Kitsos*	**Water Absorption, and Capillary Action** *Authors: Klodjan Xhexhi, Blerim Nika, Ledian Bregasi, Ilda Rusi, Sonia Jojic, and Nikolla Vesho* • **Hussain Ali Mutar**, Electrical Engineering Department, College of Engineering, Wasit University, Wasit, Iraq: **Swarm UAV–IoT Networks for Disaster Assessment: A Delay-Tolerant, Energy-Balanced Approach** *Authors: Isam Aameer Ibrahim, Ibtisam A. Aljazaery, Hussain Ali Mutar, Ibtihal R. N. ALRubeei, and Haider TH. Salim AlRikabi* • **Christos Priovolos**, Department of Materials Science, School of Natural Sciences, University of Patras, Greece: **Simulation of nitrate reduction in electrocoagulation for aluminum neat and aluminum/biochar cathode via COMSOL Multiphysics®**
13:00-16:00	**Free time**	
16:15-16:45		**HMS, Branch of Helias, Workshop Session 2 - Education & STEAM Track 2** **Chairs: M. Birba, E. Lagogianni, S. Gialpa** • **F. Spyropoulou: An Instructional Approach to the Pythagorean Theorem** • **T. Baltsavias: A Geometric Inequality Derived from the Distance Between Two Points in Any Triangle**
16:45-17:00	**Break**	

TIME	ROOM A (MAIN HALL)	ROOM B (HALL 1)
17:00-18:00	**Emerging Technologies and Innovations in Healthcare: AI, Digital Health, and Medical Imaging 1** **Chairs: S. David, K. Sofianos, G. Kolliotsis** • **Invited: Fon Hah**, Clinic to Cloud, Australia: **Artificial Intelligence- Enabled Practice Management Software: Strategic and Clinical Implications for Healthcare Delivery in Australia and Europe (30')** • **Vasileios Thomopoulos**, Department of Computer Engineering and Informatics, University of Patras, Greece: **Extending a Multilayer Agent-Based Model for COVID-19 Transmission with Public Transport and Church Attendance Layers: A Case Study for Patras, Greece** *Authors: Vasileios Thomopoulos and Panagiotis Tzoudas* • **Georgios Kolliotsis**, University of Patras, Greece: **Experimental evaluation of inorganic LGSO: Ce scintillators for applications in Medical Imaging** *Authors: Georgios Kolliotsis, Nikolaos Potiriadis, Ioannis Roussakis, Despoina Sinapi, and Stratos David*	**HMS, Branch of Helias, Workshop Session 3 - Education & STEAM Track 3** **Next-Generation STEM Practices in Primary and Secondary Education** **Chairs: A. Gioka, P. Milesi, T. Baltsavias** • **K. Desiniotis: A multifactorial model for quantifying and evaluating learning performance in STEM environments** *Authors: O. Boltsi, K. Desiniotis, E. Kremesi* • **E. Lagogianni: An exploratory approach to teaching parabola in the 1st year of high school using GeoGebra and geometric transformations** • **M. Birba & *G. Adamopoulou*: Fighting the flames – An STEM interschool study** *Authors: M. Birba, G. Adamopoulou, I. Georgiou* • **A. Ntafogianni: Game-Based Learning and Interdisciplinarity: Foundations and Practical Application through the "Panepistimonas: The Science Quiz" Game in Junior High School** *Authors: A. Ntafogianni,* E. Kolatou
18:00-18:20	**Coffee Break**	
18:20-19:05	**Emerging Technologies and Innovations in Healthcare: AI, Digital Health, and Medical Imaging 2** **Chairs: S. David, I. Roussakis, I. Tsilikis** • **Stratos David**, Department of Biomedical Engineering, University of Western Attica, Athens, Greece: **Experimental evaluation of BGO inorganic single-crystal scintillators with silicon photomultiplier (SiPM) photodetector** *Authors: Despoina Sinapi, Ioannis Roussakis, Georgios Kolliotsis, Potiriadis Nikolaos, and Stratos David* • **Ashwini Sapkal**, Department of Information Technology, Army Institute of Technology, Pune, India: **Designing a Digital Second Brain: An AI-Powered Cognitive Assistant for Memory Support and Daily Living in Alzheimer's Patients** *Authors: Ashwini Sapkal, Trupti Najan, Rachit*	**HMS, Branch of Helias, Workshop Session 4** **Chairs: A. Papadopoulos, A. Giannakopoulou, E. Kolatou** • **Invited: A. Gioka**, Teacher Education Advisor, Primary Education Directorate of Corinth, Greece: **Applying Design Thinking to Promote Inclusive and Quality Education in Primary Education (30')** • **Fotios D. Oikonomou**, University of Patras, Department of Physics, Patras, Greece: **Product-state manifolds for M quantum systems with N levels using the Fano form and the induced Euclidean metric**

	Kumar, Ishu, Pranav and Devesh Saraswat • **Ioannis Roussakis**, Department of Biomedical Engineering, University of West Attica, Greece: **Comparative Evaluation of Various Inorganic Scintillation Crystals Coupled by a SiPM Detector in the Energy Range of 81keV up to 1333keV** *Authors: Ioannis Roussakis, Nikolaos Potiriadis, Georgios Kolliotsis, Despoina Sinapi, and Stratos David*	
19:05-19:15	**Break**	
19:15-19:30	**Smart Cities, Urban Environment, and Digital Applications 2** **Chairs: A. Kyritsis, V. Thomopoulos, G. Pylarinos** • **Zakynthos Chamber of Commerce: Augmented Reality APP Presentation**	
19:30-19:40	**Break**	
19:40-21:00	**Στρογγυλό Τραπέζι: Κυκλική Οικονομία (Panel Discussion: Circular Economy – in Greek) - Moderator: Georgia Kalamara** **D. Avgerinopoulou**, Chairman of the Special Standing Committee on Environmental Protection of the Parliament **D. Aktipis**, Member of the Special Standing Committee on Environmental Protection of the Parliament **N. Giakoumelos**, Deputy Mayor for Sanitation, Zakynthos Municipality **D. Panagiotaras**, President, Associate Professor, Department of Environment, Ionian University, Greece **A. Kyritsis**, Associate Professor, Department of Environment, Ionian University, Greece **D. Golemis**, Zakynthos Chamber of Commerce **A. Alexandridis**, Professor, Department of Electrical and Computer Engineering, University of Patras, Patras, Greece	
21:30	**Conference dinner – social event, Alektor Restaurant**	

Saturday, September 26, 2026

TIME	ROOM B (HALL 1)
09:00-13:00	**Official Conference Excursion: Zakynthos half-day tour: Laganas Bay, Turtle spotting – Marathonisi – Turtle Island – Keri Caves. 4 hrs.**
11:00-12:00	**HMS, Branch of Helias, Session 5** **Chairs: A. Kalampoka, A. Kapatou, I. Konstantinidis** • **Invited: Dionysios Karavidas**, Assistant Professor, PhD - Fellow of the Higher Education Academy UK: **AI in education, advantages and concerns (15')** • **Pinelopi Milesi: Playing with Chaos** • **A. Giannakopoulou: Utilizing Artificial Intelligence and Digital Learning Tools to Enhance Student Engagement in Secondary Education** *Authors: A. Giannakopoulou, E. Varela*
12:00-12:15	**Break**
12:15-12:45	**HMS, Branch of Helias, Session 6** **Chairs: A. Papadopoulos, F. Oikonomou** • **Invited: Konstantinos Kaminakis**, Assistant Professor, Department of Marketing and Communication, Athens University of Economics and Business, Athens, Greece: **AI in Marketing: From Emerging Trends to Everyday Practice (30')**
12:45-16:45	**Free time**
TIME	**ROOM A (MAIN HALL)**
16:45-17:30	**Emerging Technologies for Smart Cities** **Chairs: C. Antonopoulos, E. Faliagka, F. Oikonomou** • **Evanthia Faliagka**, ECE Department, University of Peloponnese, Patras, Greece: **Designing Digital Twin Specifications for Urban Mobility Optimization in Patras and Nicosia** *Authors: Evanthia Faliagka, Tanya Politi, Christiana Ioannou, Ioannis Tsampras, Natalie Temene, Vasos Vassiliou, Christos Antonopoulos, Nikos Voros, Spyros Denazis* • **George R. Ivanov**, University Laboratory "Nanoscience and Nanotechnology", University of Architecture, Civil Engineering and Geodesy (UACEG), Sofia, Bulgaria: **The First 5-in-1 System for Real-Time Investigation of Langmuir Films. Monolayers from a Fluorescently Labeled Phospholipid DPPE-NBD** *Authors: George R. Ivanov and Asen Dimov* • **Ioannis Tsilikis**, Electrical and Computer Engineering Department, University of Peloponnese, Patras, Greece: **EMERGE-XR: Intent-Driven Low-Latency 5G for Real-Time Extended Reality Emergency Medical Guidance** *Authors: Ioannis Tsilikis, Christos Panagiotou, Konstantinos Antonopoulos, Michael Paraskevas, Vaggelis Kapoulas, Christos P. Antonopoulos, and Nikolaos Voros*
17:30-17:45	**Coffee break**

17:45-18:15	**Chairs: D. Panagiotaras, C. Antonopoulos, G. Pylarinos** • **Invited: Michael Meimaris**, Professor Emeritus, National and Kapodistrian University of Athens, Greece: **From Data to Meaning: Why Technology Needs Stories (30')**
18:15-18:30	**Awards** • **Best Paper (1st place, 2nd place, 3rd place)** • **Best Poster** • **Best Presentation** **Closure**
Posters	**Investigation of Microstructure, Optical and Thermal Properties of La-doped Al2O3, Synthesized via Sol-Gel** *Authors: Israa A. Najem, Wurood Asaad Midab, Shaimaa J. Kareem, Nagham Yass Khudair, Ministry of Electricity, Baghdad, Iraq* **Hybrid Forecast-Graph Reinforcement Learning for Multi-Timescale Voltage Control in Distribution Systems: Simulation Centered Evaluation of a Safe Hybrid AI Model** *Authors: Haider TH. Salim ALRikabi, Ali F. Rashid, Hussain Ali Mutar, Huda Abbas Kanber, and Ibtihal, R. Niama AL-Rubeei,* Wasit University, Iraq **A Hierarchical AI Framework for Safe RL-Based Control in Distribution Networks** *Authors: Haider TH. Salim ALRikabi,* Wasit University, Iraq **Reactive Adsorption Drives Reconstruction Lifting on O/Au(110)-(1×2)** *Authors: Stavros Karakalos, Research Core Facilities. UC Merced, Merced, California, USA* **Ethical Digital Marketing and Machine Learning: An Integrative Review and Human-Centered Conceptual Framework** *Authors: Alexios Kaponis and Manolis Maragoudakis, Ionian University, Greece* **Experimental Evaluation of DyGED for Event Detection in Dynamic Graphs** *Authors: Konstantinos Christopoulos, Nikolaos Katseris, and Christos Konstantopoulos, Department of Electrical and Computer Engineering, University of Patras, Patras, Greece*

Note: HMS, Branch of Helias sessions and panel discussions will be conducted in Greek

Plenary Speech

From Theory to Impact: Multi-Criteria Decision Making as an Engine for Applied Innovation in Sustainability and Cultural Heritage

Katerina Kabassi[1]

[1] Department of Environment, Ionian University Zakynthos, Greece

Abstract

No real-life decisions are based on a single criterion. What is the monumental value of an olive tree? And when should a large vessel alter its course to avoid a whale? Questions of this kind involve conflicting objectives, diverse data, and several stakeholders — and to address them properly, one needs more than just intuition. Multi-Criteria Decision Making (MCDM) provides a mathematical framework; software turns it into practical results. The talk outlines a 20-year research career, divided into three distinct periods. In the first period, decision-theoretic models were incorporated into intelligent systems, and different techniques were used as the basis for reasoning in intelligent graphical user interfaces, adaptive tutoring systems, and personalized e-learning. The second period involved the development of evaluation frameworks for the digital representation of culture and nature, with AHP, PROMETHEE II, TOPSIS, SAW, WPM and their fuzzy versions being applied and compared in the context of museum websites, virtual tours, the e-presence of protected areas, and environmental education programmes. In the third period, a range of tools with a direct impact on society were produced, including a cross-platform application for estimating the value of monumental trees, an MCDM framework for assessing the implementation of the 17 Sustainable Development Goals in higher education institutions, and decision-support tools for reducing large vessel collisions with marine megafauna. In these areas, there are valuable lessons that can be applied to method selection, weight determination, consistency checks, sensitivity analysis, and the design of systems for non-expert users. The talk ends by offering a roadmap that combines MCDM with artificial intelligence, crowdsourcing, and geoinformatics — viewing decision-making as the central link between evidence and action.

Assessment of the Sulfate Attack Susceptibility of Cementitious Materials in Urban Development Areas of Northeastern and Southern Kirkuk, Iraq

Mohammed Zainel Qader [1,*], Junaid Fouad Kareem [1], Elaf Mohammed Shakir [1], Lizan Ahmed Saleh [1], Hiba Hasan Sultan [1], Hiyam Ali Fadhil [1], and Belen Ali Saeed [1]

[1] North Oil Company - Field Division - Department of Geology
* Correspondence: mohammedq312@gmail.com

Abstract

Developing countries, including Iraq, are experiencing rapid population growth, necessitating additional building construction to address the housing shortage. Before construction of residential units and complexes, a comprehensive geological and engineering survey of the area and soil is required. In Kirkuk, satellite imagery analysis reveals that the city's construction rate has increased by more than 70%. Population growth in Kirkuk is more concentrated in the northern and northeastern parts of the city than in other areas. These areas are situated on the Fatha Formation, which contains significant quantities of gypsum soil and rock. To examine the site suitability, a field survey was conducted and soil samples were collected for sulfate analysis. Laboratory tests, conducted in accordance with ASTM standards, revealed that some of the sampled areas contain high levels of sulfates. Sulfates often react with ordinary Portland cement, causing various engineering problems and reducing the durability of the structures. Furthermore, the soil sample analysis revealed that the use of sulfate-resistant cement is crucial in these areas to prevent future sulfate attack on foundations and existing buildings.

Keywords: Kirkuk; sulfate-resistant cement; sulfate attack; ASTM; GIS

Investigation of Microstructure, Optical and Thermal Properties of La-doped Al_2O_3, Synthesized via Sol-Gel

Israa A. Najem [1], Wurood Asaad Midab [2]*, Shaimaa J. Kareem [3], Nagham Yass Khudair [4]

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[3] Department of Ceramic and Building Materials Engineering, College of Materials Engineering, University of Babylon, mat.shiamaa.jaber@uobabylon.edu.iq, 0000-0002-3360-7832
[4] College of Materials Engineering, Metallurgy Department, University of Babylon, Babylon City. Hilla -Iraq, naghamalbakry@gmail.com, 0009-0000-4383-1881
* Correspondence: wurood.a.midab@alsalam.edu.iq (W.A.M); Israaalnasar@gmail.com (I.A.N.)

Abstract

This study synthesized and investigated structural, morphological, optical, and thermal properties of lanthanum-doped alumina ($La_xAl_{1-x}O_3$) using the sol-gel method. The samples were synthesized using aluminum nitrate nonahydrate [$Al(NO_3)_3{\cdot}9H_2O$] and lanthanum nitrate [$La(NO_3)_3$. $6H_2O$], followed by 3 h of heat treatment at 1100 °C to obtain the phase by the sol-gel process. The results indicate that the Brunauer-Emmett-Teller (BET) surface area of La-doped alumina was 33.631 m^2/g, which is higher than that of α-Al_2O_3 (16.649 m^2/g). In addition, the 1wt% lanthanum oxide increases the thermal conductivity of $La_xAl_{1-x}O_3$ by 66%. The FESEM observation and BET analysis were used to determine the mean pore diameter and pore volume of $La_xAl_{1-x}O_3$ and α-Al_2O_3, which were 21.191 nm and 7.7268 cm^3/g, and 34.517 nm and 3.8252 cm^3/g, respectively. Atomic Force Microscopy (AFM) was employed to analyze the high homogeneity and distribution of $La_xAl_{1-x}O_3$ particles. The surface roughness of $La_xAl_{1-x}O3$ and α-Al_2O_3 was 5.07 nm and 29.37 nm, respectively. By inhibiting the sintering (agglomeration) of alumina particles at high temperatures, lanthanum oxide generates $La_xAl_{1-x}O_3$ at low temperatures. In addition, $La_xAl_{1-x}O_3$ showed absorption in the visible range.

Keywords: sol-gel; surface area; thermal conductivity; La-doped Alumina; visible property

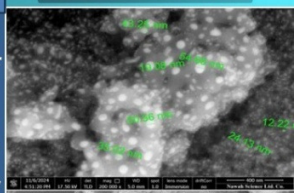
Investigation of Microstructure, Optical and Thermal Properties of La_ doped Al2O3, Synthesized via Sol-Gel

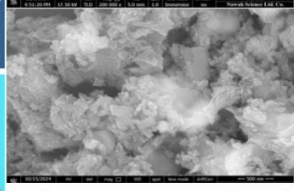


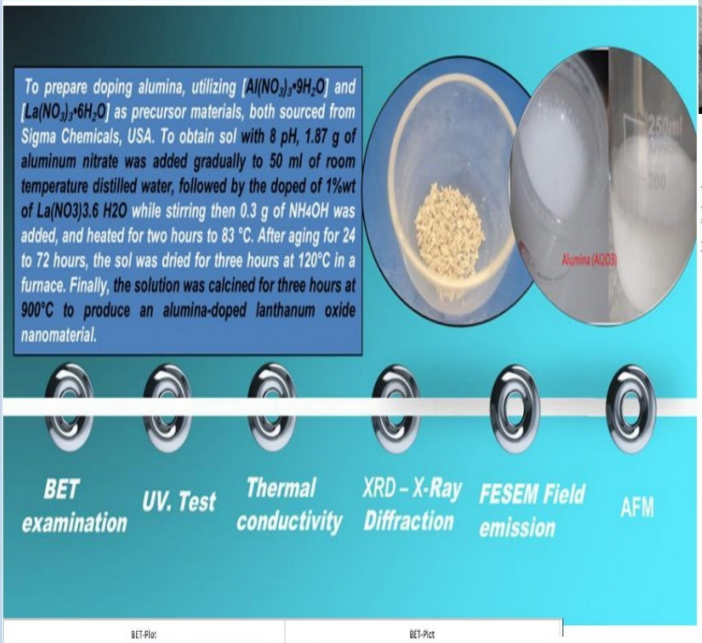
Abstract

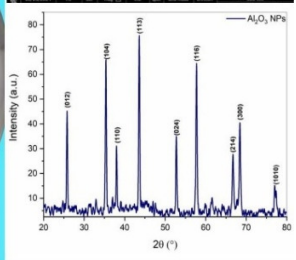
Ionic precursors were processed using sol-gel to produce a porous LaxAl1-xO3 phase with superior thermal stability. Using Al (NO3)3·9H2O and La-nitrate [La (NO3)3. 6 H2O], then after three hours of heat treatment at 1100C to generate the phase by sol-gel process. The La-doped alumina's BET surface area is 33.631 m2/g, which is higher than the alumina alpha's surface area of 16.649 m2/g. In the LaxAl1-x O3 phase, 1%wt of lanthanum oxide increases thermal conductivity by (66%). The mean pore diameter and pore volume of LaxAl1-xO3 are revealed by FESEM and BET which equal 21.191nm, 7.7268 cm3/g while alpha alumina 34.517nm, and 3.8252 cm3/g. AFM was used to analyse the high homogeneity and distribution of LaxAl1-xO3 particles, surface roughness 5.07 nm, 29.37nm of each lanthanum aluminate and alpha alumina respectively. By inhibiting the sintering (agglomeration) of alumina particles at high temperatures, lanthanum oxide generates LaxAl1-xO3 at low temperatures. In other hand, absorption into visible light LaxAl1-xO3 was acceptance.

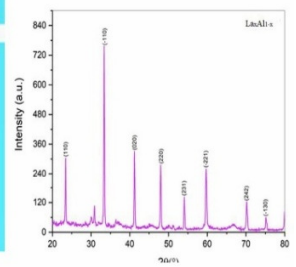
The aim of this research is to improvement the thermal performance and surface area of alumina by incorporating lanthanum oxide, which helps lower the sintering temperature and thereby increases the efficiency of solar heating systems.

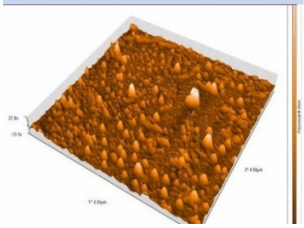


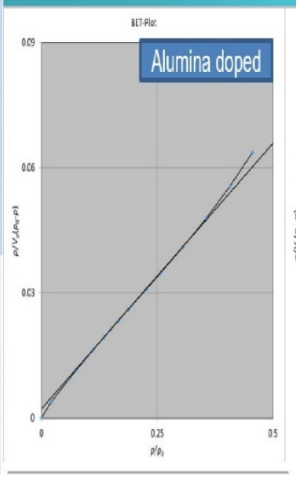


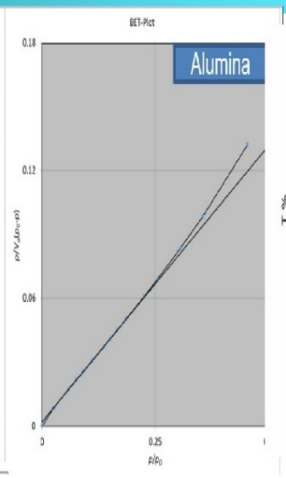


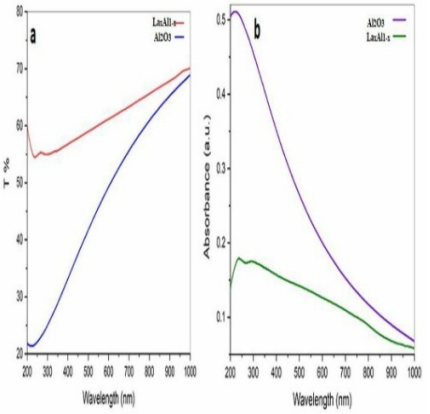












Simulation of nitrate reduction in electrocoagulation for aluminum neat and aluminum/biochar cathode via COMSOL Multiphysics®

Christos Priovolos [1*]

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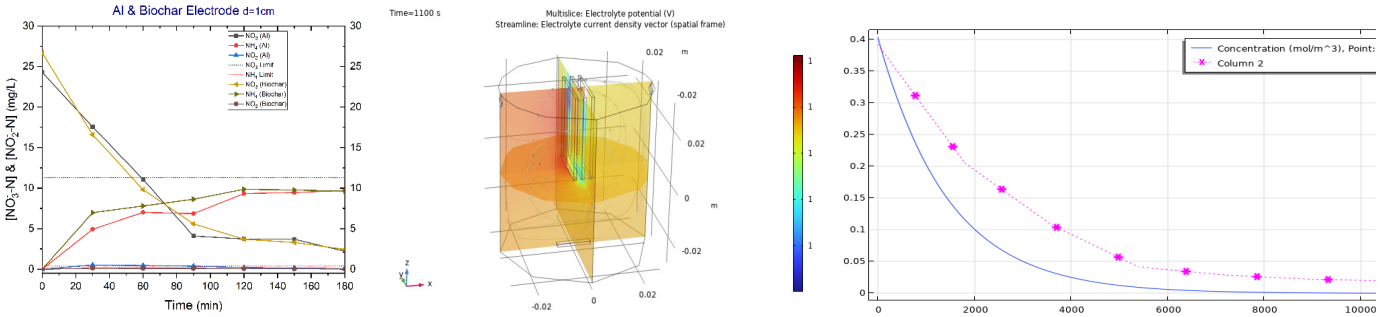
Abstract

Electrochemical nitrate (NO_3^-) abatement via electrocoagulation (EC) operates through a complex, synergistically coupled mechanism involving forced/free fluid dynamics, tertiary electrodynamics, multi-step cathodic reduction pathways, and heterogeneous adsorption onto in situ generated monomeric and polymeric aluminum hydroxide flocs ($Al_n(OH)_m^{(3n-m)+}$). At the sacrificial aluminum (Al) anode, anodic oxidation releases Al^{3+} ions that rapidly hydrolyze into active coagulants capable of destabilizing and complexing ionic species. Concurrently, cathodic processes facilitate the competitive multi-electron reduction of nitrate into nitrogenous gaseous products (N_2, NO_x) or ammonium (NH_4^+). To accurately capture these interconnected phenomena, this study presents a fully coupled 3D multiphysics model implemented in COMSOL Multiphysics®. The model resolves the continuous transport of dilute species (advection, diffusion, and electromigration via the Nernst-Planck equation), momentum transport governed by the Navier-Stokes equations, and charge conservation within both the liquid electrolyte and porous domain. By modeling a reactor architecture featuring a sacrificial Al plate anode and a high-surface-area 3D porous cathode, this framework establishes a detailed spatial-temporal profile of local current density, mass transfer boundary layers, and electro-coagulant distribution within the electrochemical cell.

Keywords*:* simulation nitrate removal, biochar activated cathode, electrocoagulation nitrate reduction.



The First 5-in-1 System for Real-Time Investigation of Langmuir Films Monolayers from a Fluorescently Labeled Phospholipid DPPE-NBD

George R. Ivanov [1,*] and Asen Dimov [1]

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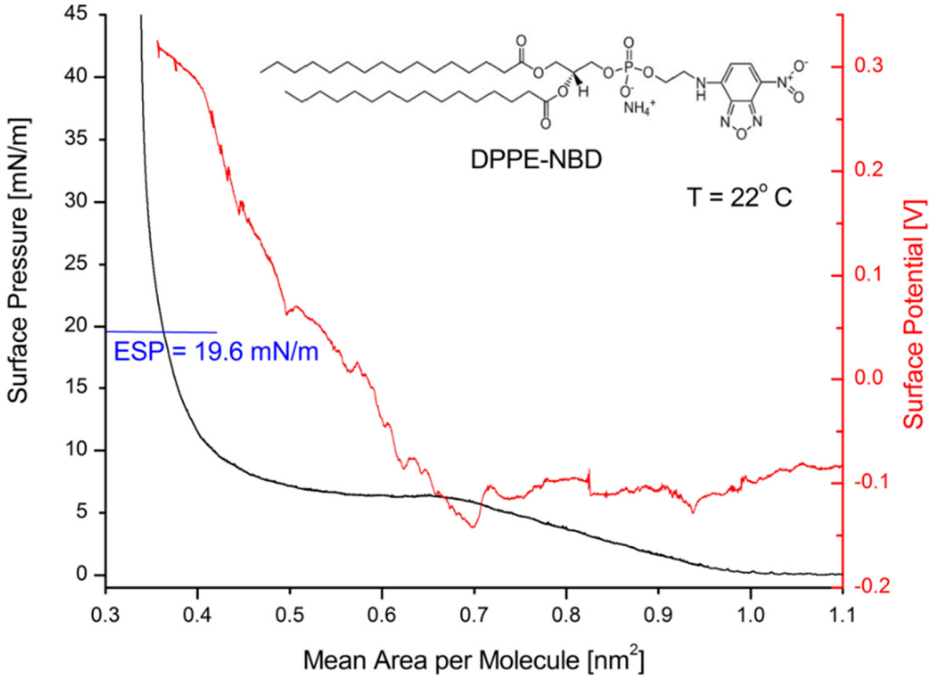
Abstract

The Langmuir-Blodgett (LB) method is a strong route for supramolecular architecture and nanoarchitectonics because it transfers organized interfacial monolayers to solids with unusually fine control over thickness, orientation, packing, and multilayer sequence. The properties and the quality of the LB film are determined by the structure and properties of the insoluble monolayer at the air-water interface (Langmuir film). We have developed an epifluorescence microscope with an additional picosecond fluorescence lifetime measurement channel. Combining these two methods with three others in the LB system delivers a 5-in-1 complementary set of methods for simultaneous study of Langmuir films. The system performance is demonstrated on monolayers of the fluorescently labeled phospholipid DPPE-NBD.

Keywords: supramolecular architecture; nanoarchitectonics; Langmuir films; Langmuir-Blodgett films; fluorescence microscopy; fluorescence lifetime measurements



Reactive Adsorption Drives Reconstruction Lifting on O/Au(110)-(1×2)

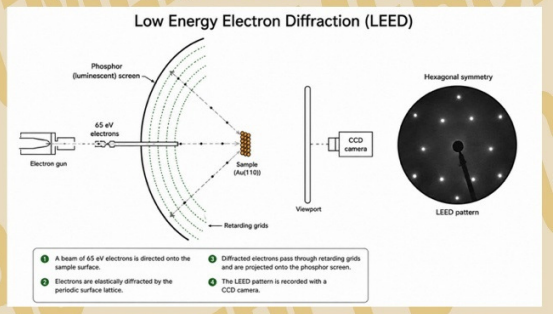
Stavros Karakalos

Research Core Facilities. UC Merced, Merced, California 95343, skarakalos@ucmerced.edu

Introduction

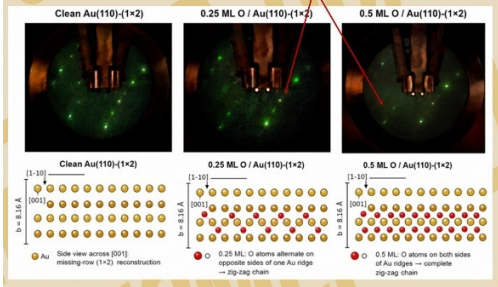
Ordered atomic oxygen layers were prepared on Au(110)-(1×2) over the coverage range 0–0.5 ML and characterized by LEED, demonstrating that the missing-row reconstruction is preserved upon oxygen adsorption. Methanol, isopropanol, and ethylamine molecular adsorption on clean Au(110)-(1×2) similarly retain the reconstructed surface structure. In contrast, reaction at the oxygen-covered interface results leading to surface intermediate formation, was accompanied by significant changes in the surface diffraction pattern. Methanol, isopropanol, and ethylamine react upon adsorption on O/Au(110)-(1×2) to yield adsorbed methoxy, isopropoxy, and ethanimine, respectively, as previously described in the literature. Study of the LEED patterns demonstrates that the Au(110)-(1×2) reconstruction is stable toward both atomic oxygen and molecular adsorption, whereas strongly bound reaction intermediates induce restructuring of the surface.

Low-Energy Electron Diffraction setup

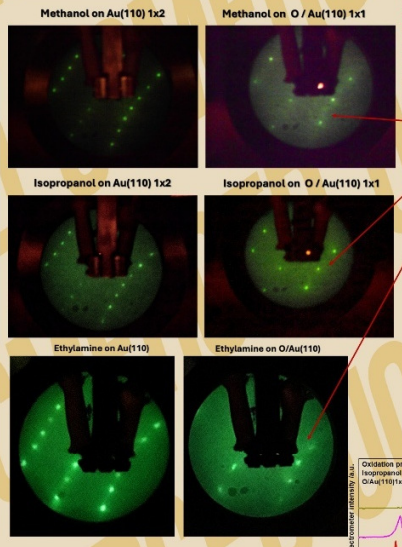


LEED images of clean Au(110)1x2 and O/Au(110)1x2

LEED spots of 1x2 surface reconstruction still detected after atomic oxygen adsorption.

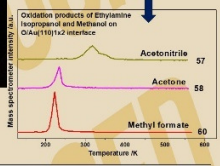


LEED images of Methanol, Isopropanol, Ethylamine on Au(110)1x2 and O/Au(110)1x1

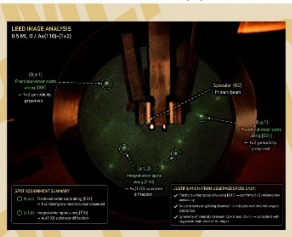


LEED spots of 1x2 surface reconstruction disappear after reactive adsorption for both oxygen-containing and nitrogen containing surface intermediates

Following LEED images with surface intermediates lifting the 1x2 reconstruction, the Au samples was heated, and the expected oxidation products were detected with mass spectrometry.



LEED spot analysis of 0.5ML O/Au(110)1x2



Conclusions

- Oxygen adsorption up to 0.5 ML preserves the Au(110)-(1×2) missing-row reconstruction, consistent with the formation of ordered oxygen zig-zag chains on the reconstructed surface.
- Molecular adsorption of methanol, isopropanol, and ethylamine does not lift the Au(110)-(1×2) reconstruction, indicating that adsorption of intact reactant molecules alone is insufficient to induce surface restructuring.
- Reactive adsorption produces significant changes in the LEED patterns, demonstrating that the formation of strongly bound surface intermediates (methoxy, isopropoxy, and imine species) drives reconstruction lifting.
- The reconstruction-lifted surfaces exhibit structural characteristics consistent with the c(2×2)-ordered Au(110)-(1×1) phase previously observed for carboxylate-covered Au(110), suggesting a common adsorbate-stabilized surface structure.
- The results extend the concept of adsorbate-induced restructuring from oxygen-containing intermediates to nitrogen-containing species, indicating that surface reconstruction is a general consequence of strongly bound adsorbates.
- Overall, the study establishes a direct relationship between surface intermediate formation and structural evolution at the O/Au(110) interface, highlighting the dynamic nature of Au surfaces under reaction conditions and the critical role of reactive adsorption in determining catalyst surface structure.

Funding and acknowledgements

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Recycled Composite Panels for Sustainable Interior Architecture: Density, Water Absorption, and Capillary Action

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Abstract

This study evaluates the physical performance of recycled wood- and plastic-based composite panels made from pine, olive, and beech wood, and plastic granules, bonded with a Cement-Based Adhesive (CBA). Density, water absorption, and capillarity tests were performed on panels of 25 × 25 × 2 cm. The tests were conducted after 12, 24, and 48 h in accordance with EN ISO 15148. Three samples per category were analyzed using ANOVA. Results indicate that olive-based panels recorded the lowest dry density (0.495 g/cm³) and the lowest average capillary rise (17 cm), while plastic-based panels showed the highest capillary rise (25 cm) and higher water absorption (up to 43.96%). Pine panels exhibited the highest moisture content (up to 52.56%), whereas beech panels had moderate capillary rise (20 cm) and lower moisture variation. Despite their relatively low bulk density and favorable aesthetic qualities, olive and beech panels demonstrated reduced strength, limiting their structural application. Overall, the results indicate that these composite panels are more suitable for indoor non-structural architectural uses, such as decorative elements and suspended ceiling systems.

Keywords: composite recycled panels; wood and plastic granules; cement-based adhesive; density; water absorption; capillary Action; indoor panels

Investigation of Natural Convection Heat Transfer in Two Vertical Heated Walls Partially Filled with Porous Media

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Abstract

The study presents a comprehensive numerical and experimental investigation into natural convection heat transfer within two vertical heated parallel plates, comparing a clean air configuration against channels fully and partially filled with copper metal foam. The research characterizes the complex interplay between the enhancement provided by the foam's high surface area and the flow resistance introduced by Darcy-Forchheimer drag. For the porous regions, the Brinkman- Forchheimer extended Darcy model was employed under local thermal equilibrium (LTE) assumptions, while a low Reynolds number K-ε turbulence model was utilized to resolve high-buoyancy flows. The investigation spans Rayleigh numbers (10^6, 5×10^6, 10^7, 5×10^7), porosity (0.85, 0.9, 0.95), and pore densities (10, 20, 30, 40). Results indicate that metal foam significantly augments thermal performance, with a porosity of 0.85 yielding an 87.3% enhancement over clean air at Ra = 5×10^7. One of the partial cases was identified as the optimal configuration for balancing thermal enhancement with reduced pressure drop. Notably, an inverse relationship was observed between pore density (PPI) and the Nusselt number, as higher PPI values significantly suppress fluid circulation.

Keywords: Natural convection; Porous metal foam; Nusselt number.

Simulation-Based Intelligent Multi-Aircraft Formation Navigation System Using PID Control and Particle Swarm Optimization Under Realistic Environmental Conditions

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Abstract

This paper presents the design, implementation, and performance evaluation of an intelligent multi-aircraft formation navigation system that integrates Proportional, Integral, Derivative (PID) control with Particle Swarm Optimizations (PSO) for adaptive and cooperative fleet management. The proposed framework enables autonomous coordination of up to eight aircraft in multiple geometric formations, including line, triangular, square, and circular configurations, under realistic environmental conditions. A modular system architecture is developed, incorporating a navigation controller, decoupled PID-based attitude stabilization, a formation management module, and a comprehensive environmental model that accounts for wind, turbulence, temperature, humidity, pressure, and visibility effects. The control system employs three independent PID loops for roll, pitch, and heading dynamics, ensuring stable and responsive behaviors across varying flight conditions. To enhance system performance, a real-time PSO-based optimization module is introduced to adaptively adjust inter-aircraft spacing, maximizing fleet efficiency. The system is evaluated within a large-scale simulation environment using multiple weather scenarios and fleet configurations. Results demonstrate that the proposed control framework achieves a settling time of approximately 6 s with less than 10% overshoot for attitude stabilization. The system maintains high stability under nominal conditions (stability index > 0.88) and degrades gracefully under severe disturbances while preserving formation integrity. Furthermore, the PSO-based optimizations improve fleet efficiency by up to 23.7% compared to fixed-spacing approaches. Scalability analysis confirms consistent performance for fleet sizes ranging from one to eight aircraft. The integration of realistic environmental modelling and multi-objective performance evaluation distinguishes the proposed approach from existing methods.

Keywords: Multi-aircraft systems; Formation control; PID control; Particle Swarm Optimization; Autonomous navigation; Environmental modelling.

Designing a Digital Second Brain: An AI-Powered Cognitive Assistant for Memory Support and Daily Living in Alzheimer's Patients

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Abstract

Alzheimer's disease (AD) is a progressive cognitive disorder that causes memory and orientation loss and decreased autonomy. The article is a plan for how to design and roll out an AI-based cognitive assistant, the Digital Second Brain (DSB), that can provide adaptive memory support and cognitive reinforcement to AD patients. DSB integrates multimodal inputs, long-term memory modules, and Retrieval-Augmented Large Language Models (RAG-LLMs) to imitate personalized recall, conversation, and emotional support. DSB is a benefit-enhancing personalized digital companion that improves recall and supports caregivers through multi-knowledge graph thinking, real-time reflection, and safe-response validation. This application is a neurocognitive implementation of modern AI, providing an empathetic, explainable, and context-aware digital memory extension, and in full compliance with HIPAA/GDPR.

Keywords: Alzheimer's disease; cognitive assistant; artificial intelligence; long-term memory; knowledge graph; dementia care; NLP; retrieval-augmented generation; healthcare technology

Low-Cost BLE AoA Exploration Capabilities Leveraging Statistical Analysis of RSSI and I/Q Features

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Abstract

Bluetooth Low Energy (BLE) has been widely adopted for indoor positioning applications aimed at providing context-aware services. Early BLE localization approaches primarily rely on Received Signal Strength Indicator (RSSI) measurements, whose accuracy is often limited by multipath propagation, fading, and environmental interference. To address these limitations, BLE v5.1 introduced the Direction Finding (DF) feature, which supports Angle of Arrival (AoA) estimation and enables more accurate indoor positioning. However, this feature relies on multiple-antenna arrays, increasing hardware complexity, deployment constraints, and system costs. To address these challenges, this work explores the feasibility of classifying discrete distance and angular sectors using single-antenna devices by exploiting statistical features extracted from RSSI and In-phase/Quadrature (I/Q) measurements. Experimental results exhibited classification accuracies of 86.3% for distance estimation and 76.7% for angle estimation, thereby demonstrating the feasibility of extracting localization-relevant information from RSSI and I/Q measurements using resource-constrained single-antenna BLE devices.

Keywords: Bluetooth Low Energy (BLE); Indoor Localization; Angle of Arrival (AoA); RSSI; I/Q Signal Analysis; Machine Learning; IoT Localization

Best Presentation Award

Designing Digital Twin Specifications for Urban Mobility Optimization in Patras and Nicosia

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Abstract

As urban challenges grow increasingly complex, Open Digital Twin Frameworks (ODTFs) offer a sustainable and adaptable approach to managing the dynamic inter-play between urban infrastructure, environmental sustainability, and societal needs. This study presents the implementation process of MetaCities ODTF framework for smart cities. The importance of this ODTF lies in its ability to unify diverse data sources, technologies, and stakeholders under a common architecture. It proposes a versatile ODTF framework that can be tailored to diverse use cases within various regional contexts to address the unique needs of cities and regions across Southeast Europe (SEE) landscape. The study adopts three consecutive phases. The first phase identified high-impact use-cases regarding smart mobility together with their data sources and high-level technical workflows, resulting in a set of functional and technical requirements. The second phase translated these requirements into detailed ODTF specifications. In the final phase, the ODTF specifications were mapped to individual platform components, connecting each component in the corresponding requirements and use cases. By bridging digital, physical and human layers, Digital Twins built on the ODTF provide a reliable, real-time reference environment in which stakeholders can safely evaluate policy options and infrastructure investments prior to full-scale deployment.

Keywords: Open Digital Twin Framework; ODTF; Digital Twin; architectural components; Smart Mobility; Urban Mobility; Smart City; Internet of Things; IoT

Exploiting Teachers' Proficiency in Harnessing Artificial Intelligence for Physical Education

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Abstract

This paper examines the application of Artificial Intelligence (AI) in the field of Physical Education (PE), with emphasis on PE teachers' knowledge, attitudes, and perceptions. The study explores the level of understanding and acceptance of AI among educators, focusing on benefits, challenges, and prospects for integration into teaching practices. The results indicate significant gaps in PE teachers' knowledge of AI and limited familiarity with its potential applications in teaching. At the same time, positive attitudes toward the prospect of leveraging AI were identified, with the majority of participants recognizing its potential benefits. The results also highlight challenges such as the lack of PE teachers' professional development, technological inequalities, and concerns about data privacy.

Keywords: Physical Education; Artificial Intelligence; Knowledge; Attitudes; Perceptions

Invited Speech – Applied Sciences & Digital Innovation in Secondary Education Workshop

AI in Marketing: From Emerging Trends to Everyday Practice

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Invited Speech – Applied Sciences & Digital Innovation in Secondary Education Workshop

AI in education, advantages and concerns

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Abstract

As generative artificial intelligence (AI) becomes ubiquitous in modern classrooms, traditional educational paradigms—historically anchored in a linear Teacher→ Knowledge → Student model—are undergoing a profound transformation. This keynote address examines the dual nature of AI in education, weighing its immense potential as a personalized tutor, differentiation tool, and Socratic facilitator against the hidden risks of cognitive outsourcing. Rather than treating AI merely as an instrument for academic dishonesty or viewing it as an adversarial threat, the presentation argues for a pedagogical shift from strict avoidance to active AI literacy. Through practical cross-disciplinary examples—such as economic elasticity calculations and physics problem-solving—the paper demonstrates that AI-generated outputs often contain subtle conceptual errors disguised as authoritative certainty. Consequently, the core competency for modern students is no longer the rote production of answers, which AI has rendered cheap, but the critical evaluation of them: knowing what to ask, recognizing underlying flaws, independently verifying results, and reasoning without technological dependence. Ultimately, the future of education lies in the collaborative synergy of educators and AI, fostering students who possess the critical thinking, logic, and intellectual resilience required to navigate an automated world.

Keywords*:* Artificial Intelligence in Education (AIEd), AI Literacy, Critical Thinking, Pedagogical Innovation, Higher Education.

Applied Sciences & Digital Innovation in Secondary Education Workshop

Fighting the flames – STEM interschool study

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Abstract

In an era where the climate crisis is radically altering the natural environment, schools are called upon to cultivate citizens with scientific literacy and active social participation. This paper presents a project implemented within the framework of the European Space Agency's (ESA) "Climate Detectives" competition, in which 6th-grade elementary and 1st-grade high school students from neighboring schools collaborated to investigate the relationship between rising atmospheric temperature and drought—attributed to climate change—and the increasing intensity and frequency of forest fires in our region. The mixed student groups utilized data from the National Observatory of Athens, the Hellenic National Meteorological Service, the Pyrgos Forestry Service, ESA's EO Browser, Google Earth, and the Hellenic Cadastre to study temporal changes in temperature, precipitation amounts and frequency, forest cover, and the number and extent of fires. Statistical analysis of the data revealed an increase in average summer temperatures and an extension of the dry period, factors that favor the outbreak and spread of major forest fires. At the same time, precipitation appears to be becoming less frequent but increasingly torrential, while forests recover quickly following the devastating fires that have struck them. The research concluded with the design and construction of a prototype early fire-warning system on the Arduino platform, which records and wirelessly transmits real-time temperature, humidity, and CO_2 concentration data. The collaboration of students from different educational levels fostered social, STEM, and critical thinking skills, adopting a scientific mindset to channel environmental concern into action.

Keywords: mathematical analysis, climate change, forest fires, STEM

Applied Sciences & Digital Innovation in Secondary Education Workshop

Exploring Geometric and Topological Models through 3D Printing: Utilizing Holden and Escher 3D Models in a School STEAM Group

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Abstract

This paper presents the utilization of 3D printing within the framework of a middle school STEAM extracurricular club. Students participated in activities involving the search, digital analysis, and study of 3D models, their digital preparation, as well as the printing and assembly of complex geometric structures. Through this process, they familiarized themselves with basic concepts of 3D design, developed spatial perception, collaboration, and creative problem-solving skills, while also understanding the relationship between digital design and physical construction. The results of the initiative highlight the contribution of 3D printing to the implementation of Maker Movement principles and the creation of authentic learning experiences that enhance active student participation. The experience from the club's operation demonstrates that the integration of digital manufacturing technologies into the school environment can be a significant factor in enhancing the STEAM educational process.

Keywords: 3D printing, Maker Movement, STEAM, experiential learning, digital fabrication

Applied Sciences & Digital Innovation in Secondary Education Workshop

Utilizing Artificial Intelligence and Digital Learning Tools to Enhance Student Engagement in Secondary Education

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Abstract

The rapid advancement of digital technologies, particularly Artificial Intelligence (AI), creates new prospects for transforming the educational process. This paper presents a literature review exploring the integration of digital learning tools, Augmented Reality (AR) applications, and generative artificial intelligence tools into Secondary Education teaching. By synthesizing modern research data, it aims to highlight how these technologies enhance student engagement, support differentiated instruction, and foster 21st-century skills such as collaboration, critical thinking, and creativity.

The study examines proposed instructional scenarios and implementation frameworks that leverage interactive learning platforms, AI tools for producing customized educational material, and AR applications for visualizing complex concepts. Literature findings demonstrate that the structured pedagogical application of AI and AR contributes to increased student interest and active participation, improves understanding of subject matter, and fosters a more interactive, inclusive, and student-centered educational environment.

Keywords: Artificial Intelligence, Digital Learning Tools, Augmented Reality, Literature Review, Innovative Teaching Practices, Secondary Education

Applied Sciences & Digital Innovation in Secondary Education Workshop

Applying Design Thinking to Promote Inclusive and Quality Education in Primary Education

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Abstract

Inclusive education is a cornerstone of quality learning, ensuring equitable participation for all students. This paper presents a primary school educational scenario aligned with UN Sustainable Development Goal 4 (Quality Education). Designed for 5th and 6th graders, the project fosters empathy, collaboration, and active citizenship by transforming the classroom into a learning community. Grounded in experiential learning, Problem-Based Learning, Design Thinking, and Universal Design for Learning (UDL), students progress through three phases: exploring social exclusion, co-designing interventions, and creating digital and physical prototypes (such as Tinkercad 3D models, Canva posters, and educational robotics). Formative assessment tools like rubrics and peer reviews promote student autonomy and reflection. Ultimately, the scenario demonstrates how inclusion as a daily practice builds a democratic school culture where every student thrives as an equal member of the educational community.

Keywords: Inclusive education, Active citizenship, Universal Design for Learning (UDL), Design Thinking, Experiential learning, Primary education

From Educational Intervention to Mathematical Modeling: A Multi-Factor STEM Learning Model

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Abstract

This paper proposes and mathematically investigates a novel multifactorial model for quantifying and evaluating learning outcomes within STEM educational environments. Drawing upon the principles of multiplicative production functions of the Cobb-Douglas type, the model conceptualizes total learning as a function of three interconnected and complementary dimensions: conceptual understanding , skills development , and collaboration. Furthermore, it incorporates an environmental quality coefficient (α) to account for the impact of the instructional setting. The mathematical rigorous analysis of the model demonstrates the presence of positive monotonicity, diminishing marginal returns, and weak Edgeworth-Pareto complementarity among the factors. Through simulation scenarios and the assessment of distinct learning profiles, it is pedagogically validated that a holistic and balanced development of all three dimensions maximizes learning efficacy, whereas deficiency in a single domain imposes a severe penalty on overall performance. The proposed framework aspires to serve as a robust decision-support tool for educators and policymakers in designing and evaluating integrated STEM curricula.

Keywords: Learning Modeling, STEM Education, Cobb-Douglas Function, Factor Complementarity, Educational Evaluation

An exploratory approach to teaching parabola using GeoGebra and geometric transformations

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Abstract

Teaching quadratic functions in 1st-grade high school is challenging, as it often relies on plotting tables of values rather than connecting algebraic expressions with geometric properties. This paper presents an alternative teaching proposal utilizing GeoGebra, grounded in inquiry-based learning and multiple representations theory. Starting from the basic parabola, students use dynamic sliders to explore how parameters affect position, orientation, and shape through geometric transformations, bypassing tables of values. A key innovation is the reverse process: students determine a quadratic function's equation directly from its graph by analyzing geometric features like vertex, axis of symmetry, and opening scale, avoiding algebraic systems. This approach enhances conceptual understanding, fosters smooth transitions between mathematical representations, and promotes student-centered digital tool use in mathematics education.

Keywords: Quadratic functions, GeoGebra, Inquiry-based learning, Multiple representations, Geometric transformations

Gaming with Chaos

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Abstract

The topic of this presentation explores how to introduce 9th-grade students to a complex mathematical concept like Chaos Theory without starting from daunting, advanced equations. Instead, the proposed approach suggests starting with play. By immersing students in interactive, game-based learning experiences, they can discover firsthand that a system governed by precise, deterministic rules can still evolve in a wildly unpredictable manner. Through this experiential exploration, young learners grasp the delicate balance between order and chaos, experiencing the butterfly effect and non-linear dynamics intuitively. This playful methodology bridges abstract mathematical theory with concrete engagement, fostering critical thinking, curiosity, and a deeper appreciation for the complex patterns hidden within everyday phenomena.

Keywords: Chaos theory, 9th-grade mathematics, game-based learning, non-linear dynamics, inquiry-based learning, mathematical intuition

A Geometric Inequality That Can Arise from The Distance Between Two Points in Any Triangle

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Abstract

Geometric inequalities have frequently been set as problems in mathematics competitions. Often, a geometric inequality stems from the distance between two points. A classic example is the inequality stating that the circumradius of a triangle is at least twice its inradius. What is the distance from which this inequality originates? It is the distance between the circumcenter and the incenter of a triangle, which is expressed by a well-known formula involving the square of that distance, a formula that students of past decades learned as Euler's formula.This article will follow a similar path. It will present a geometric inequality, prove it, and then show that this inequality stems from the distance between two points of a triangle. The author believes that formulas expressing distances can lead someone to perceive the corresponding geometric inequalities in a more tangible way. He acknowledges that considerations of this kind cannot be taught in regular school classrooms, but only to students preparing for mathematics competitions.

Keywords: Keywords: distance, triangle, vertex, Euler circle

Applied Sciences & Digital Innovation in Secondary Education Workshop

Game-Based Learning and Interdisciplinarity: Foundations and Practical Application through the "Panepistimonas: The Science Quiz" Game in Junior High School

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Abstract

This paper explores the role of game-based learning through a literature review and the design of the digital game "Polymath: The Science Quiz." A bibliographic review of hybrid learning formats is conducted, examining the cognitive and emotional benefits of integrating games in the classroom, along with the role of feedback. Successful implementation depends on the teacher, as pedagogical beliefs, adaptability, and digital literacy enhance the transition toward student-centred outcomes. As a practical application, the digital game "Polymath: The Science Quiz" is presented for reviewing Natural Sciences and Mathematics in the 9th Grade, promoting creativity and collaboration. The paper highlights the link between pedagogical foundations and collaborative tools, and examines prospects for their integration into the curriculum.

Keywords: Digital game, Game-based learning, Interdisciplinarity, Lower Secondary School

Applied Sciences & Digital Innovation in Secondary Education Workshop

An Instructional Approach to the Pythagorean Theorem

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Abstract

Beginning its historical presence in the Babylonian era and its demonstrative elevation by Pythagoras, the Pythagorean Theorem was initially used for practical geometric and construction calculations. It was primarily utilized in its algebraic form across almost all sciences (physics, engineering, etc.) and became recognizable even in domains of non-Euclidean geometry. Starting from Pythagoras, Euclid, and Pappus of Alexandria, we will proceed, using Information Technology, to present the calculation of area relationships for squares related to the sides of a right-angled triangle. Information and Communication Technologies, specifically the dynamic geometry software GeoGebra, become an essential tool for the effective and easy study of intertwined and complex mathematical shapes and relations. In this way, both students and teachers are given the opportunity to engage deeply and creatively with the approaches of the Pythagorean Theorem, responding to contemporary pedagogical-didactic demands as well as technological developments. At the same time, we will apply the phenomenological idea of objectification to the teaching of the Pythagorean Theorem—that is, the transformation of an abstract geometric concept into tangible, visual, and hands-on models.

Keywords: Pythagorean Theorem, objectification, Information and Communication Technology, visualization

Best Paper Award – 2nd Place

Urban Landscape Configuration and Seasonal Land Surface Temperature in Metropolitan Athens

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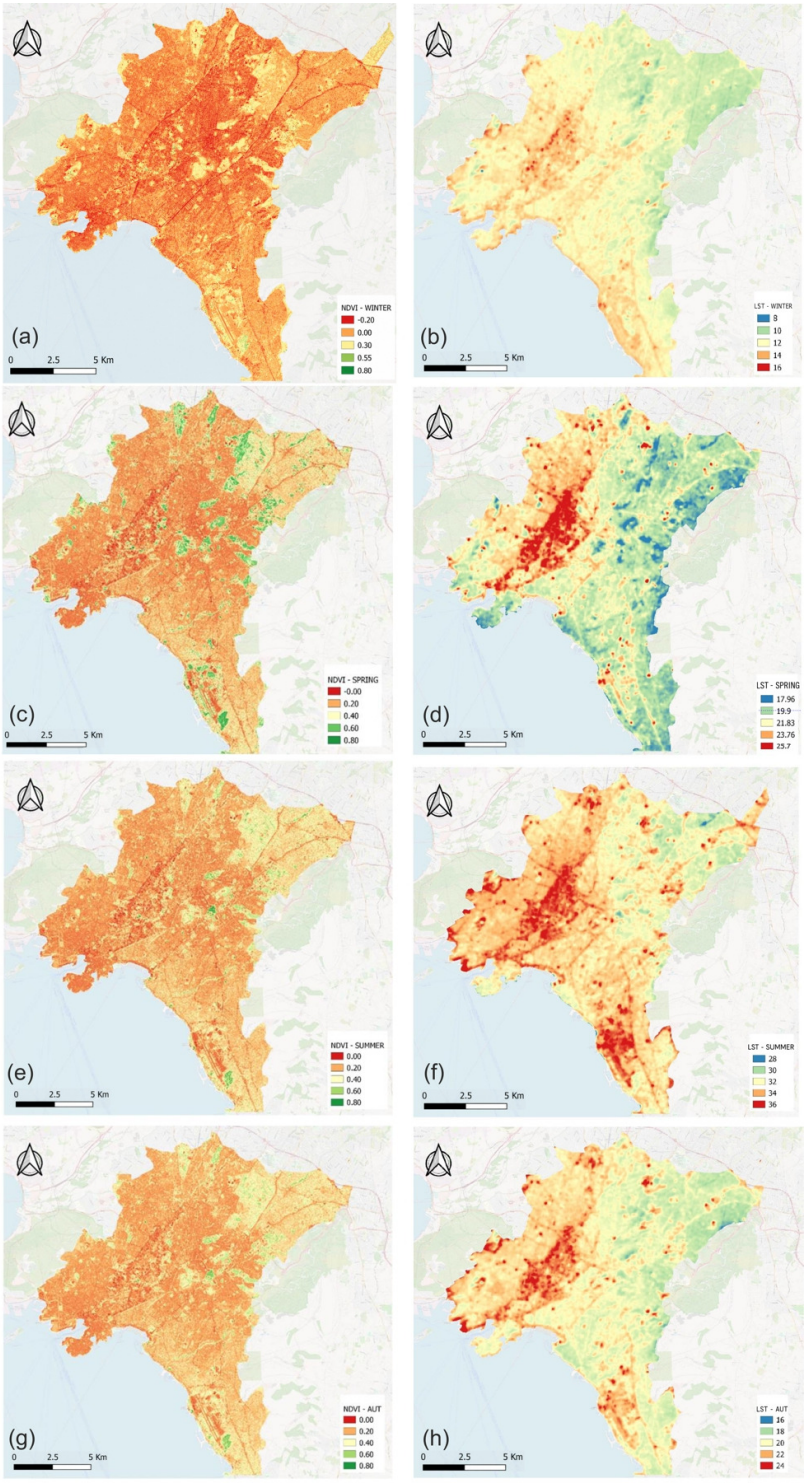
Abstract

Urban vegetation and the spatial configuration of land-cover classes play an important role in regulating Land Surface Temperature (LST), although their influence also depends on topography and the wider urban setting. This study examined seasonal LST and urban landscape patterns across metropolitan Athens, Greece. LST was estimated for 30 municipal and sub-municipal units utilizing nine cloud-screened Landsat 8 OLI/TIRS images acquired in 2020. Twelve landscape metrics were calculated from a thematic land-cover map produced by object-based classification of high-resolution orthophotographs. To examine the seasonal relationships between landscape structure and LST, global regression and geographically weighted regression (GWR) were used. Vegetation cover ranged from 12.10% to 41.35%, while mean built-up cover was 74.60%. At the point scale, Normalized Difference Vegetation Index (NDVI) and LST had a strong negative relationship in every season (R^2 = 0.752–0.912). At the district scale, vegetation cover was most strongly associated with summer LST (R^2 = 0.528). The winter topographic GWR model showed the strongest fit (R^2 = 0.787), with elevation emerging as the dominant negative predictor of LST. Nevertheless, every GWR model had a higher AICc than its corresponding global model (ΔAICc = 0.055–14.390). The local models therefore helped reveal spatial variation, but they were not more parsimonious. The results show how vegetation, urban form, analytical scale, and topography jointly shape seasonal surface-temperature patterns in metropolitan Athens and can inform locally adapted green-infrastructure planning.

Keywords: urban green infrastructure; land surface temperature; Landsat 8; NDVI; landscape metrics; object-based image analysis; geographically weighted regression; Athens



Seasonal spatial patterns of NDVI (left column) and LST (right column, °C) in 2020: (a, b) winter, (c, d) spring, (e, f) summer, and (g, h) autumn

Computer Vision – Based Approach for Estimating Dimensions of Olive Trees

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Abstract

Olive trees are intricately linked to the Mediterranean culture, cuisine and regional economies. Within agricultural and environmental research, the monumental value of olive trees attracts considerable interest from the global scientific community. However, assessing this value remains challenging, as the age of most olive trees is often unknown, and the required manual measurements demand domain experience within a Multi-Criteria Decision-Making (MCDM) framework. This study investigates whether a single RGB photograph can provide reliable estimation of key structural dimensions. It proposes a computer vision-based model, that leverages image processing and machine learning techniques to automate and improve the evaluation of olive tree monumental value, trained on a dataset of 300 olive trees expanded from a pilot of 50. The experimental results indicate that the proposed Convolutional Neural Network (CNN) model achieved Mean Absolute Error (MAE) of 2.07 m for base perimeter, 1.66 m for perimeter at breast height, and 2.17 m for total height. Compared to linear regression baselines, the deep learning approach reduced prediction errors up to 26.3%. This demonstrates that single-image based estimation is a feasible alternative to traditional measurement methods.

Keywords: monumental olive trees; artificial intelligence; computer vision; Multi-Criteria-Decision-Making

Hierarchical Bayesian Spatial Framework for Air Quality Imputation in Sparse Sensor Networks

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Abstract

Ground-based air quality monitoring networks in Southern Europe are often sparse, leaving large areas, such as rural plains, mountain ranges, and island groups, unmonitored. Standard spatial interpolation methods like Inverse Distance Weighting or Kriging struggle under these conditions, since they cannot easily incorporate physical terrain or provide reliable uncertainty estimates. This paper presents a Hierarchical Bayesian Spatial framework to address the sparse sensor coverage. We model the annual mean concentration of particulate matter ($PM_{2.5}$) across Greece using data from the European Environment Agency (EEA) e-Reporting network for 2023. We combine ground measurements with terrain elevation from digital elevation models. The continuous spatial surface is discretized using a Finite Element mesh via Stochastic Partial Differential Equations (SPDE). We fit the model deterministically using Integrated Nested Laplace Approximations (INLA). Adding terrain elevation and a sum-to-zero spatial constraint resolved parameter baseline confounding. The model fit improved significantly, increasing the marginal log-likelihood from −41.97 to −39.87. The model achieved an R^2 of 0.91 and a Root Mean Square Error (RMSE) of 2.83 $\mu g/m^3$. The global national baseline concentration was thus estimated at 17.74 $\mu g/m^3$ (95% Credible Interval: [11.34, 23.88]). Elevation indicated a negative effect ($\beta_{elev} = -7.24 \mu g/m^3$ per km), with an 89.2% posterior probability of reducing $PM_{2.5}$. Spatial autocorrelation persisted across a regional scale of $\rho \approx 297$ km. Full posterior variance mapping identified Crete, the Ionian and the Aegean Seas, and Eastern Thrace as zones of maximum predictive uncertainty. These findings provide a quantitative baseline for prioritizing physical sensor deployment in undersampled regions.

Keywords: Bayesian Statistics, R-INLA, SPDE, Air Quality, Uncertainty Quantification, Spatial Interpolation, Environmental Engineering, $PM_{2.5}$.

GIS-Based Multicriteria Assessment and Spatial Mapping of Urban Quality of Life: The Case of Zakynthos, Greece

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Abstract

Zakynthos is a small coastal city where environmental conditions, compact urban development, and strong seasonal tourism pressures influence everyday living conditions. This study examines how these factors shape urban quality of life (QoL) across the city using a GIS-based multicriteria framework. A literature review indexed in JSTOR, PubMed, and Scopus, completed in early 2026, guided indicator selection. Nine criteria—estimated population density, the Normalized Difference Vegetation Index (NDVI), public recreation, accessibility, Land Surface Temperature (LST), proximity to forests and the sea, road-related acoustic suitability, imperviousness, and nighttime lighting—were standardized to a 0–100 scale and combined using Analytic Hierarchy Process (AHP) weights. The analysis brings together satellite-derived environmental variables and detailed local information on buildings, recreational spaces, services, and roads on a common 10 m grid. This level of detail is particularly useful in a small Mediterranean city, a setting that remains underrepresented in GIS–AHP studies of QoL. Moderate QoL covered 30.86% of the study area, while the low and very low classes together accounted for 41.24%. Only 3.12% was classified as very high. Higher scores were primarily observed along the northern coast and in vegetated regions. In contrast, central and southwestern neighborhoods typically scored lower due to heat, impervious surfaces, traffic noise, and fewer recreational options. However, some central areas still maintain good access to services. The maps illustrate the local trade-offs between accessibility and environmental quality, offering a detailed baseline to identify zones where targeted planning actions may be necessary.

Keywords: urban quality of life; GIS; multicriteria evaluation; analytic hierarchy process; spatial equity; remote sensing; Zakynthos

From Meteorological Recovery to Soil-Water Persistence: A Native-Grid Multiscale Drought Framework for the Ionian Islands, Greece (1981-2024)

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Abstract

Drought monitoring on small islands is challenged by coastline-grid mismatch and by the possibility that meteorological recovery precedes recovery of soil-water conditions. This study presents a native-grid, area-weighted framework for the Ionian Islands using Climate Hazards Center Infrared Precipitation with Stations version 3 (CHIRPS v3), TerraClimate potential evapotranspiration, and modelled soil-water storage for 1981-2024. The framework preserves each product's original spatial support, derives monthly island series, calculates the Standardized Precipitation Evapotranspiration Index (SPEI) at 1-, 3-, 6-, and 12-month scales, constructs a drought-event catalogue, evaluates temporal trends, and quantifies soil-water recovery. It identified 690 scale-specific events; longer accumulation scales produced fewer but more persistent events. No generalized robust intensification was detected. Full-period negative SPEI-3 signals in Kefalonia and Ithaca were sensitive to the 2020-2024 terminal period, while the remaining island trends were not significant after false discovery rate adjustment. In 34.3% of completed events, modelled soil-water storage remained below normal when SPEI first returned to nonnegative values. Recovery lags had a median of 0 months, a 90th percentile of 4 months, and a maximum of 20 months. The framework provides a transparent, transferable basis for drought monitoring and water-resource planning in insular environments.

Keywords: drought monitoring; Standardized Precipitation Evapotranspiration Index; CHIRPS; TerraClimate; soil-water storage; Ionian Islands; water resource management; geoinformatics

Diachronic Assessment of the Suitability of Bee Habitats within the Natura 2000 Areas of Crete

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Abstract

Climate change, habitat degradation, and extreme weather events are increasingly threatening pollinators in Mediterranean ecosystems. This study evaluates the spatial and temporal suitability of bee habitats within the Natura 2000 site "Selinary–Vrachasi" (GR4320013), Crete, from 2017 to 2025. A GIS-based multi-criteria decision analysis was created using the Analytic Hierarchy Process, with criteria weights assigned by experts. Dynamic indicators such as nectar availability (*MSAVI*), pollen resources (*NDYI*), and moisture conditions (*NDWI*) were derived from Sentinel-2 imagery in *Google Earth Engine*, while topographic factors such as thermal suitability, terrain slope, and topographic shelter were extracted from a digital elevation model. Interannual standard deviation was used to evaluate climate-related instability. Results show significant spatial fragmentation: 45.96% of the area is moderately suitable but highly vulnerable to drought; 37.60% was highly suitable and resilient; and 16.44% was unsuitable. The resilient zones identified should be prioritized for conservation, managed beekeeping, and early-warning systems based on satellite data.

Keywords: bee habitat suitability; multi-criteria decision analysis; Analytic Hierarchy Process; Sentinel-2; Natura 2000; climate risk; Crete

An Integrated Sustainable Floriculture Model Combining Soilless Propagation Systems, Auxin Optimization and Industry 4.0 Automation

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Abstract

Floriculture needs propagation protocols that combine biological efficiency with digital control. This synthesis integrates two factorial studies on *Salvia rosmarinus* and *Lavandula angustifolia* with a qualitative Industry 4.0 greenhouse pilot. In *Salvia rosmarinus*, the propagation system was the strongest source of variation in shoot height and root length ($F = 511.92$ and 226.62, respectively; $p < 0.001$); detailed Tukey comparisons placed the highest observed shoot- and root-length means in float treatments and the highest branching mean in mist, with several leading treatments statistically comparable. In *Lavandula angustifolia*, general-linear-model estimated marginal means indicated approximately 20–30% greater root length and greater branching under aeroponics than under mist or float; no post hoc multiple comparisons were available. Auxin-formulation responses were secondary and species-dependent. The PlantBot architecture links Internet of Things sensing, artificial intelligence, robotics, and radio-frequency identification, but has not yet been quantitatively validated for resource efficiency. The evidence therefore supports a hierarchical model in which system selection establishes the rooting environment, auxin provides conditional enhancement, and automation supports control and traceability. Future validation should include a true no-IBA control and automated-versus-conventional comparisons of biological performance, water, energy, labour, reliability, and cost.

Keywords: aeroponics; soilless propagation; auxins (IBA); Industry 4.0; sustainable floriculture

Swarm UAV–IoT Networks for Disaster Assessment: A Delay-Tolerant, Energy-Balanced Approach

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Abstract

This study proposes an integrated Unmanned Aerial Vehicle–Internet of Things (UAV–IoT) framework for disaster assessment in the presence of damaged or unavailable communication infrastructure. The proposed system combines ground IoT sensing, UAV swarm data ferrying, High-Altitude Platform (HAP) support, Delay-Tolerant Networking (DTN), Multi-Agent Reinforcement Learning (MARL), and game-theoretic task offloading to improve data delivery, energy balance, and fault tolerance. The collapse of communication networks in disaster areas significantly affects response mechanisms, with such interruptions seriously weakening the dissemination and acquisition of information. This study introduces a new integrated model using Swarm UAV networks and ground IoT sensors for building a robust disaster verification system. The proposed design utilizes a delay-tolerant energy-balanced architecture to mitigate the obstacles posed by intermittent connectivity and constrained energy. The architecture deploys a hierarchical coordination model in which the UAV swarm serves as the mobile data ferry to transport data from IoT sensors towards HAPs. To address this challenge, this paper proposes a hybrid optimization scheme by fusing the MARL method for UAV coordination to maximize the aggregated energy efficiency with game-theoretic task offloading for distributed computation. Simulation results under the defined disaster-response scenarios show that the proposed approach reduces emergency-data delivery latency by 62%, extends UAV swarm operational lifetime by 51%, and maintains approximately 85% data-transfer performance under 30% UAV failure. These results represent a vast improvement over current approaches, validating the framework's potential to transform disaster response by providing stable communication and assessment in times of degraded traditional infrastructure.

Keywords: Swarm UAV Networks; Energy-Balanced Optimization; AI, Internet of Things; disaster assessment; delay-tolerant networking

Best Poster Award

A Hierarchical AI Framework for Safe RL-Based Control in Distribution Networks

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Abstract

The use of Solid-State Transformers (SSTs) for intelligent coordination and integration between medium voltage feeders, dispersed energy sources, fast EV charging, and hybrid AC/DC loads is becoming significantly more prevalent. The control options available with these devices provide better controllability compared with standard low-frequency transformers. However, the development of this high degree of controllability introduces numerous coupling issues associated with voltage, power flow, thermal, and modulation, which are reported in the literature concerning cascaded-based control, especially under renewable variability and parameter drift. This study describes a physics-informed safe Reinforcement Learning (RL) controller for three-stage SSTs. The methodology consists of combining an actor-critic supervisory controller, a graph-temporal encoder, a power balance and thermal-residual regularizer, and a quadratic-program-based safety shield. The purpose of this safety shield is to project each AI action onto the feasible operating space of the SST before arriving at the inner converter loops. The supervisory controller coordinates the setting of active/reactive power references, DC link targets, and the setting of DAB phase-shift before MPC/PI based inner loops and enabling rapid actuation. A stochastic digital twin was developed for a 1 MVA distribution-grade SST under various operating scenarios, including PV ramps, EV charging pulses, MV sags, islanding transitions, and converter-parameter drift. Across 40 stochastic scenarios, the proposed controller achieved a settling time of 8.17 ms (95% CI +/- 0.24), output THD of 1.77% (+/- 0.06), efficiency of 97.43% (+/- 0.05), hotspot temperature of 84.86 °C (+/- 0.44), and a constraint-violation rate of only 1.07% (+/- 0.12). Relative to a strong model predictive control baseline, settling time improved from 12.42 to 8.17 ms, efficiency increased from 96.08% to 97.43%, and hotspot temperature reduced from 91.38 °C to 84.86 °C; paired tests were highly significant for all primary metrics ($p < 0.001$). Compared with DRL without physics regularization, the proposed method remained faster (11.35 ms vs. 8.17 ms) and safer due to a fourfold lower violation rate. The primary contribution of this study is the co-design of AI-based supervisory coordination, physics-residual shaping, and hard action projection for SST operation. This integrated design provides a simulation-based foundation for subsequent real-time digital-simulation, controller-hardware-in-the-loop, and experimental validation studies.

Keywords: solid-state transformer; dual-active-bridge; reinforcement learning; physics-informed control; thermal-aware scheduling; distribution grids

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A Hierarchical AI Framework for Safe RL-Based Control in Distribution Networks

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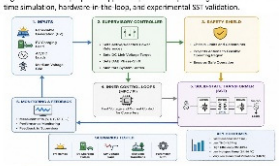
Electrical Engineering Department, College of Engineering, Wasit University, Wasit, Iraq

1 Abstract

Solid-State Transformers (SSTs) enable flexible integration of medium-voltage feeders, distributed energy resources, fast EV charging, and hybrid AC/DC loads. However, their high controllability introduces complex voltage, power-flow, thermal, and modulation interactions. This study proposes a physics-informed safe Reinforcement Learning (RL) controller for three-stage SSTs. The framework integrates an actor-critic supervisory controller, graph-temporal encoder, physics-based regularization, and a QP-based safety shield. The safety shield projects control actions onto the SST's feasible operating region before implementation. The controller coordinates active/reactive power, DC-link voltage, and DAB phase-shift references. A 1 MVA stochastic digital twin was evaluated under PV ramps, EV charging pulses, voltage sags, islanding, and parameter drift. Across 40 scenarios, the proposed method achieves 8.17 ms settling time, 1.77% THD, and 97.43% efficiency. It also maintained a hotspot temperature of 84.66 °C and only 1.07% constraint violations. Compared with MPC, the method provided faster response, higher efficiency, and lower hotspot temperature ($p < 0.001$). It also achieved a fourfold lower violation rate than DRL without physics regularization. The proposed approach provides a promising foundation for real-time simulation, hardware-in-the-loop, and experimental SST validation.



2 The Objective and Contributions

Objective

To develop a **physics-informed safe reinforcement learning framework for three-stage Solid-State Transformers (SSTs)** that enables fast, efficient, and reliable coordination of power flow, DC-link voltage, and DAB phase shift under renewable variability and changing operating conditions.

Contributions

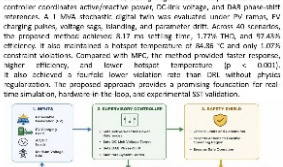
- **Physics-informed safe RL:** Integrates actor-critic control with graph temporal learning and physical constraints.
- **Safety shield:** Uses **QP-based action projection** to guarantee feasible SST control actions.
- **Coordinated SST control:** Optimizes **active/reactive power, DC-link voltage, and DAB phase-shift.**
- **Robust validation:** Evaluated using a **1 MVA stochastic digital twin** across 40 challenging operating scenarios.
- **Improved performance:** Achieves **8.17 ms settling time, 97.43% efficiency, 1.77% THD, and only 1.07% constraint violations,** outperforming MPC and conventional DRL approaches.

3 Comparative review highlighting the gap that motivates the proposed work..

Study	Year	Method	Setting	Strength	Gap
[1]	2013	Review	Applications and applications	Converter topology survey	No AI; no safety-aware real-time control
[2]	2019	Review	SST-based microgrids	Design-oriented synthesis	Pre-AI control era
[3]	2021	Review	Power electronic transformers	Magnetics and converter design	Limited control intelligence
[10]	2024	DRL	DAB modulation	RL improves wide-range modulation	Single converter stage only
[11]	2025	DRL-PI	DAB voltage control	Data-driven PI tuning	No multi-port SST coordination
[12]	2024	Hybrid control	Hybrid SST for distribution grids	Multifunctional grid support	Conventional supervisory logic
[28]	2025	Review	SST control stages	Architecture-control mapping	No unified AI safety framework
[29]	2025	Review	Hybrid distribution SST control	Compares control system approaches	Limited stochastic performance metrics
[30]	2025	Predictive control	Frequency support in SSTs	ReCoP: constrained support	Narrow service objective
Present study	2026	Physics-informed safe RL	Three-stage SST	Joint voltage-power-thermal-safe control	Simulation-based only

4 Proposed Hybrid AI Framework

The proposed controller is a hierarchical physics-informed safe RL architecture. Measured port variables and estimated latent states are passed through a graph temporal encoder that represents the SST as a small multi-port interaction graph. The actor-critic head outputs supervisory references, while the safety shield enforces feasibility before commands reach the inner loops.

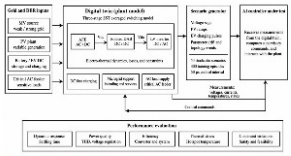


5 Training and inference flow of the proposed control framework

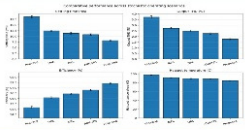


6 Experimental Setup

A scenario-based stochastic digital twin was developed to evaluate the controller under renewable-rich operating conditions. The model represents a 1 MVA three-stage SST with converter dynamics, thermal behavior, measurement noise, and system uncertainties. The scenario generator varies solar/wind generation, grid strength, load composition, temperature, and converter parameters. This approach enables statistical evaluation across a wide range of controlled operating conditions. The study is simulation-based only, with no hardware-in-the-loop or physical prototype validation claimed.



7 Results



Method	Settling time (ms)	THD (%)	Efficiency (%)	Hotspot T (°C)	Violation rate (%)
PI Droop	18.56 +/- 2.42	3.92 +/- 0.11	95.17 +/- 0.13	97.28 +/- 0.68	8.84 +/- 0.82
MPC	12.44 +/- 0.24	2.74 +/- 0.08	96.01 +/- 0.05	93.26 +/- 0.51	3.88 +/- 0.29
DRL	11.55 +/- 0.18	2.55 +/- 0.06	96.45 +/- 0.04	89.91 +/- 0.43	5.32 +/- 0.37
ANN-TPS	10.83 +/- 2.38	2.28 +/- 0.67	96.81 +/- 0.23	88.52 +/- 0.61	3.06 +/- 0.23
Present study	8.17 +/- 0.24	1.77 +/- 0.06	97.43 +/- 0.03	84.66 +/- 0.44	1.07 +/- 0.13

8 Conclusions & Future Work

This paper presented a physics-informed safe RL framework for supervisory control of three-stage SSTs in renewable-rich distribution grids. The proposed architecture integrates graph-temporal learning, physics-based regularization, and a QP-based safety shield while retaining conventional inner control loops. Across 40 stochastic scenarios, it achieved 8.17 ms settling time, 1.77% THD, 97.43% efficiency, 84.66 °C hotspot temperature, and 1.07% constraint violations. The framework significantly outperformed PI-Droop, MPC, DRL, and ANN-assisted scheduling across key performance metrics. Ablation studies confirmed that physics-based regularization improves dynamic and thermal performance, while safety projection ensures feasible operation. The approach effectively adapts to renewable fluctuations, EV charging pulses, MV voltage sags, and converter parameter drift. However, the current results are limited to average-model simulations and do not demonstrate hardware readiness. Future work will focus on HIL, Power-HIL, and scaled-prototype validation, including latency, protection, switching effects, thermal accuracy, and safe fallback operation.

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An Agent-Based Simulation of the Greek Electricity Market under Extreme Weather Scenarios

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Abstract

Greece's electricity system—with annual demand of approximately 57 TWh and renewable penetration exceeding 50% in 2024–2025—faces growing operational risk from weather-driven supply–demand imbalances. We developed an agent-based model (ABM) implemented in Mesa (Python) that simulates the full national market over a complete annual cycle (1 June 2024–31 May 2025). The model comprises 24 autonomous agents—6 producer agents (solar, wind, biomass, natural gas, hydro, lignite), 15 consumer agents (two national aggregates plus 13 regional nodes), 2 transaction agents (imports, exports), and 1 baseline data agent—parameterized directly from ADMIE, RAE, ELSTAT, and Ember data sources. Baseline validation against ADMIE records yields an annual production error of +0.35% (57.2 TWh simulated vs. 57.0 TWh) and monthly source-level correlations above 0.95. Four extreme-weather scenarios are applied and evaluated using a resilience index R: a 21-day Dunkelflaute event (R = 0.965), 24 heatwave days (R = 0.985), four hypothetical PV curtailment events (R = 0.996), and a 7-day storm (R = 0.992). The Dunkelflaute scenario produces the highest unserved energy (1.4 TWh), corresponding to a daily storage requirement of 65–70 GWh sustained over multiple consecutive days.

Keywords: agent-based modeling; electricity market simulation; renewable energy integration; grid resilience; extreme weather; energy grid

Hybrid Forecast-Graph Reinforcement Learning for Multi-Timescale Voltage Control in Distribution Systems: Simulation-Centered Evaluation of a Safe Hybrid AI Model

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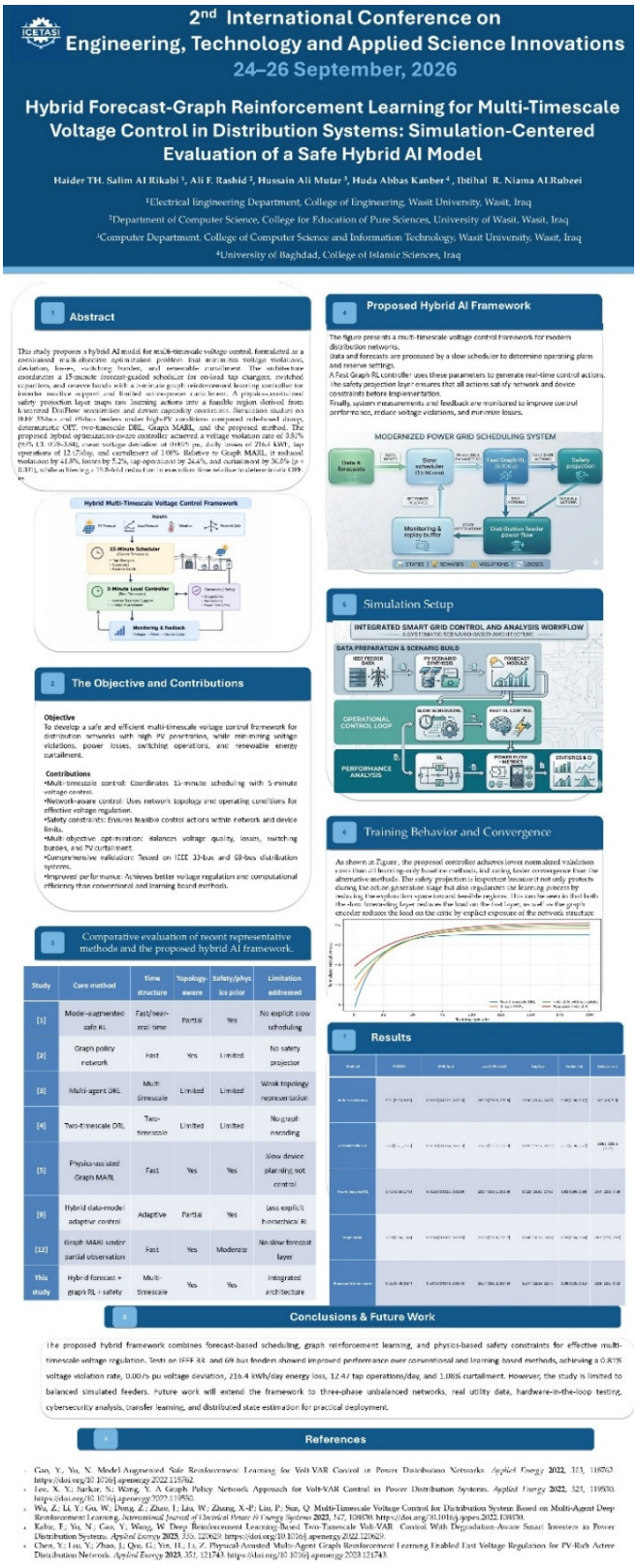
Abstract

In a distribution system, high penetration of Inverter-Based Distributed Energy Resources creates a time-coupled, uncertain, and complex solution space for voltage regulation, as it cannot be easily regulated using either time-synchronized mechanical regulators or data-driven control algorithms without some form of predictive insight into future conditions. This study proposes a hybrid AI model for multi-timescale voltage control, formulated as a constrained multi-objective optimization problem that minimizes voltage violations, deviation, losses, switching burden, and renewable curtailment. The architecture coordinates a 15-minute forecast-guided scheduler for on-load tap changers, switched capacitors, and reserve bands with a 5-minute graph reinforcement learning controller for inverter reactive support and limited active-power curtailment. A physics-constrained safety projection layer maps raw learning actions into a feasible region derived from linearized DistFlow sensitivities and device capability constraints. Simulation studies on IEEE 33-bus and 69-bus feeders under high-PV conditions compared rule-based droop, deterministic OPF, two-timescale DRL, Graph MARL, and the proposed method. The proposed hybrid optimization-aware controller achieved a voltage violation rate of 0.81% (95% CI: 0.78-0.84), mean voltage deviation of 0.0075 pu, daily losses of 216.4 kWh, tap operations of 12.47/day, and curtailment of 1.08%. Relative to Graph MARL, it reduced violations by 41.8%, losses by 5.2%, tap operations by 24.4%, and curtailment by 36.0% ($p < 0.001$), while achieving a 15.8-fold reduction in execution time relative to deterministic OPF.

Keywords: multi-timescale voltage control; distribution systems; hybrid AI; graph reinforcement learning; Volt/VAR control; safe optimization



Study	Core method	Time structure	Topology-aware	Safety/physics prior	Limitation addressed
[1]	Model-augmented safe RL	Fast/near-real-time	Partial	Yes	No explicit slow scheduling
[2]	Graph policy network	Fast	Yes	Limited	No safety projector
[3]	Multi-agent DRL	Multi-timescale	Limited	Limited	Weak topology representation
[4]	Two-timescale DRL	Two-timescale	Limited	Limited	No graph encoding
[5]	Physics-assisted Graph MARL	Fast	Yes	Yes	Slow device planning not control
[6]	Hybrid data-model adaptive control	Adaptive	Partial	Yes	Less explicit hierarchical RL
[12]	Graph MARL under partial observation	Fast	Yes	Moderate	No slow forecast layer
This study	Hybrid forecast + graph RL + safety	Multi-timescale	Yes	Yes	Integrated architecture

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Experimental Evaluation of DyGED for Event Detection in Dynamic Graphs

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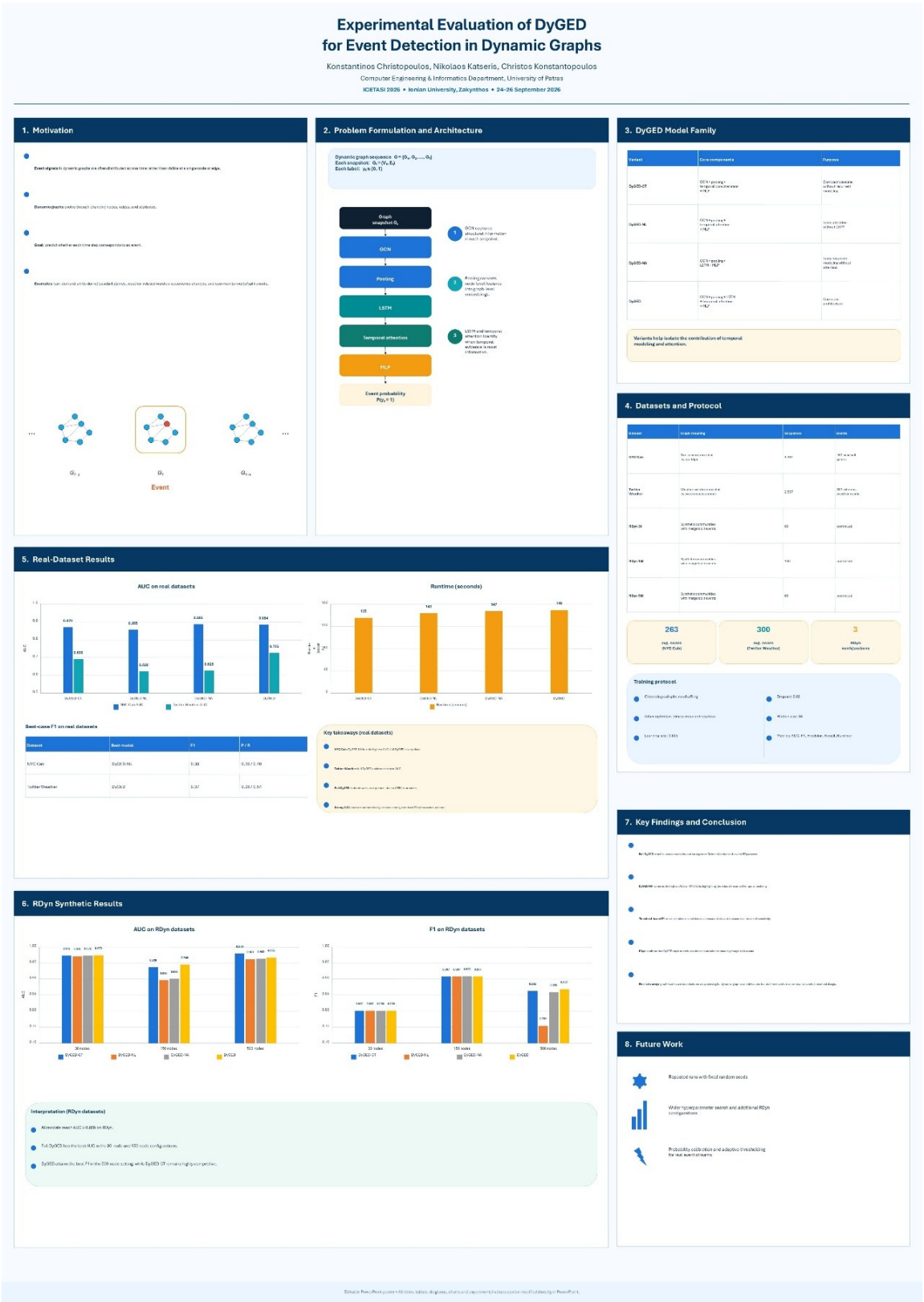
Abstract

Event detection in dynamic graphs focuses on recognizing time instants at which the structure or attributes of an evolving graph differ meaningfully from their ordinary patterns. Dynamic Graph Event Detection (DyGED) is a graph-level deep learning framework that integrates graph convolution, graph pooling, recurrent temporal processing, and temporal attention to capture the relationships between graph-level dynamics and annotated events. This study presents a comprehensive evaluation of DyGED and three associated variants, DyGED-CT, DyGED-NL, and DyGED-NA. The assessment follows the supervised DyGED formulation introduced with DyGED, while expanding the empirical analysis through reporting runtime performance, evaluating threshold-based F1 scores, and examining additional synthetic dynamic graphs generated with RDyn. Experiments are conducted on NYC Cab and Twitter Weather datasets, using three RDyn configurations that included controlled community merge and split events. The findings indicate that the complete DyGED architecture is a reliable and competitive model, particularly for Twitter Weather and several RDyn scenarios. However, the threshold-based evaluation reveals that a high Area Under the ROC Curve (AUC) score does not necessarily translate into strong precision-recall performance when positive events are infrequent. Additionally, the synthetic experiments suggest that DyGED-style models are more effective at identifying community-level structural changes when the event pattern is clearly defined and controlled experimentally.

Keywords: dynamic graphs; event detection; anomaly detection; graph neural networks; DyGED; RDyn; synthetic dynamic graphs


Experimental Evaluation of DyGED
for Event Detection in Dynamic Graphs
Konstantinos Christopoulos, Nikolaos Katseris, Christos Konstantopoulos
Computer Engineering & Informatics Department, University of Patras
ICETASI 2025 • Ionian University, Zakynthos • 24-26 September 2026
1. Motivation
Event
2. Problem Formulation and Architecture
Graph snapshot
GCN
Pooling
LSTM
Temporal attention
MLP
Event probability
3. DyGED Model Family
Variants help isolate the contribution of temporal modeling and attention.
4. Datasets and Protocol
263
300
3
Training protocol
5. Real-Dataset Results
AUC on real datasets
Runtime (seconds)
Best-case F1 on real datasets
Key takeaways (real datasets)
6. RDyn Synthetic Results
AUC on RDyn datasets
F1 on RDyn datasets
Interpretation (RDyn datasets)
7. Key Findings and Conclusion
8. Future Work

Best Paper Award – 3rd Place

Extending a Multilayer Agent-Based Model for COVID-19 Transmission with Public Transport and Church Attendance Layers: A Case Study for Patras, Greece

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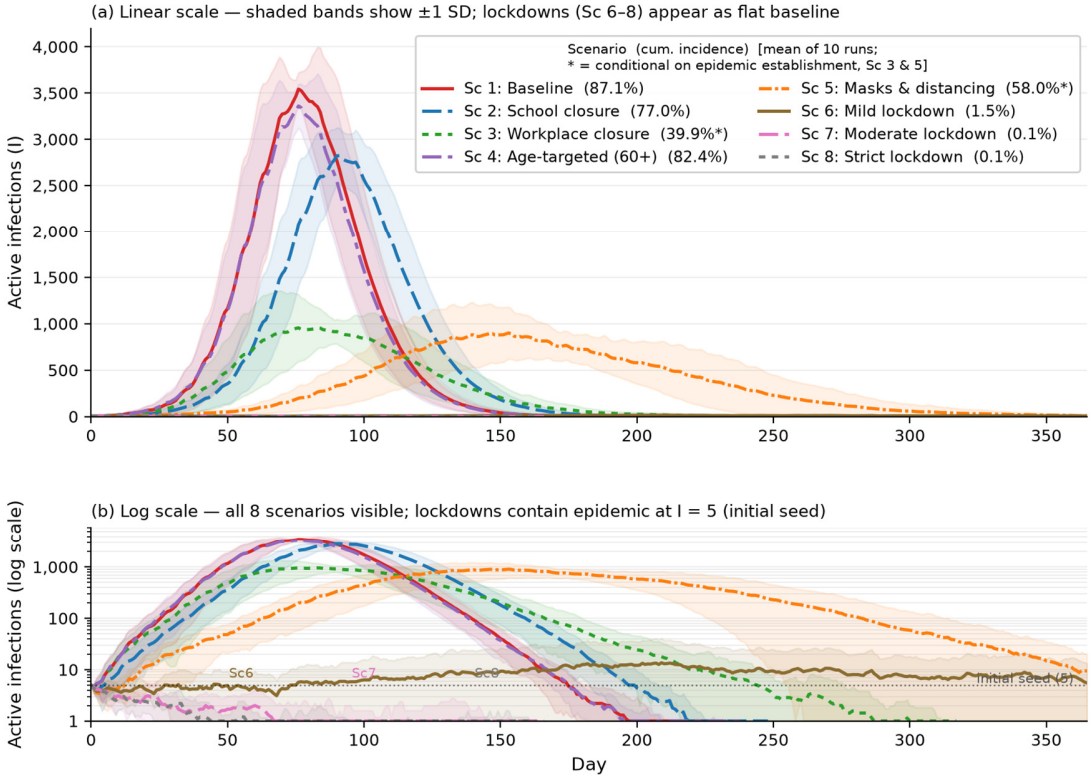
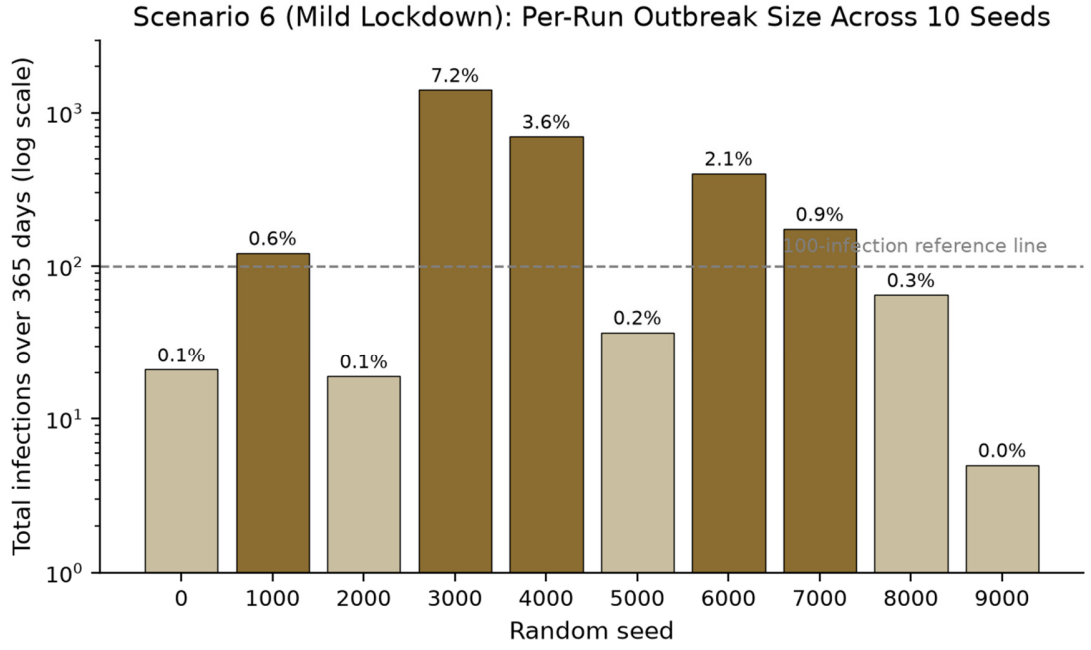
Abstract

Epidemiological agent-based models (ABMs) offer a detailed, behavior-based alternative to aggregate compartmental approaches by representing heterogeneous populations and enabling the simulation of targeted non-pharmaceutical interventions. This study extends a previously developed synthetic-population ABM for COVID-19 transmission in the central district of Patras, Greece, by introducing two new interaction layers: a public transport layer and a church attendance layer. In addition, the school assignment mechanism is enhanced to reflect the age-appropriate structure of local educational institutions. The model follows a SEIRD compartmental structure and is implemented using the Mesa framework for Python. The public transport layer captures 13% of agents who use one of ten urban bus lines on weekdays and Saturdays, whereas the church attendance layer assigns 5% of the population to one of twenty parishes active exclusively on Sundays. Household transmission parameters are grounded in empirical household secondary attack rate estimates from the COVID-19 literature, yielding a simulated within-household secondary attack rate of approximately 22% and an estimated basic reproduction number $R_0 \approx 3.3$. Eight intervention scenarios are evaluated across ten stochastic replications each. Moderate and strict lockdown scenarios (Scenarios 7–8) reliably reduce the effective reproduction number below 1, limiting cumulative incidence to under 0.3%. Mild lockdown (Scenario 6), in contrast, exhibits near-critical stochastic behavior, with a mean incidence of 1.5%. Individual Scenario 6 replications range from near-extinction to a 7.2% attack rate. The outcome distribution is heavy-tailed, so the mean understates the risk of any single implementation near the epidemic threshold. Workplace closure and masks-and-distancing scenarios are found to operate near the epidemic threshold, producing bimodal outcomes: in 30% and 10% of replications, respectively, the epidemic goes extinct before becoming established. In the remaining runs, attack rates of approximately 40% and 58% are observed. The case-fatality rate across epidemic scenarios ranges from 0.85% to 1.18%. The age-targeted intervention selectively protects the highest-mortality subgroup, reducing cumulative mortality by 27.5%. As the model has not yet been validated against empirical Greek epidemiological time series, these findings should be read as an exploratory comparison of intervention scenarios rather than as calibrated predictions.

Keywords: agent-based modeling; COVID-19; SEIRD model; synthetic population; multilayer networks; epidemic simulation; Patras; reproduction number

Figure 2. Active infection trajectories under eight intervention scenarios
(mean of 10 runs, shaded ±1 SD, 365-day horizon, n = 19,600)





Best Paper Award – 1st Place

EMERGE-XR: Intent-Driven Low-Latency 5G for Real-Time Extended Reality Emergency Medical Guidance

Ioannis Tsilikis [1, 2,*], Christos Panagiotou [1], Konstantinos Antonopoulos [1], Michael Paraskevas [1,2], Vaggelis Kapoulas [2], Christos P. Antonopoulos [2] and Nikolaos Voros [2]

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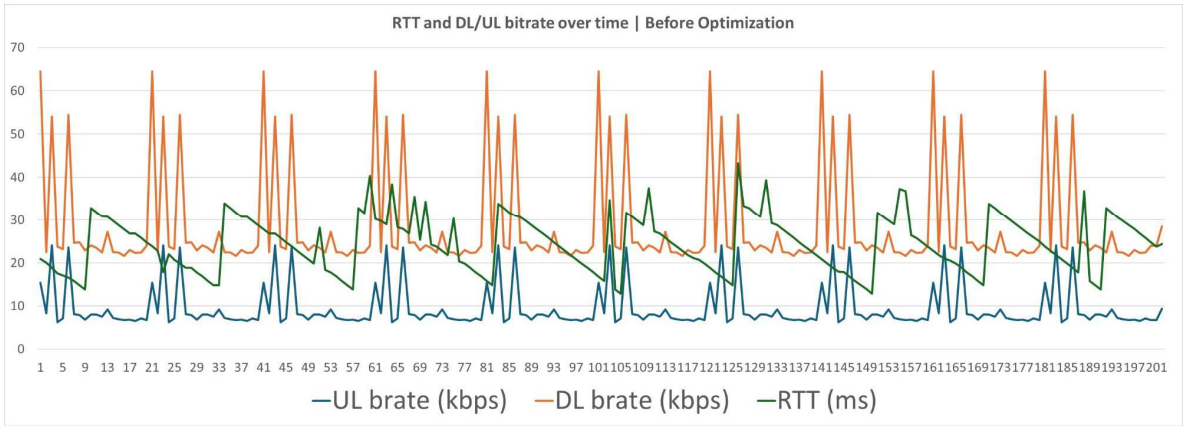
Abstract

Extended Reality (XR) applications for emergency medical response impose stringent latency requirements that commodity fifth-generation (5G) deployments do not satisfy by default. This paper presents EMERGE-XR, a real-time XR system delivering AI-driven medical guidance to first responders, and addresses the research problem of how Medium Access Control (MAC)-layer parameter tuning on a software-defined 5G gNodeB (gNB) can reliably achieve sub-10 ms round-trip time (RTT) for interactive XR workloads. The system integrates Meta Quest 3 augmented reality (AR) headsets, edge-hosted pose estimation, and a clinical decision-support workflow based on the ABCDE trauma assessment protocol. The clinical guidance component has been functionally demonstrated on the laboratory testbed but has not yet been evaluated in a user study; the experimentally validated contributions of this work concern the network-layer optimization and the profile-switching mechanism, not the clinical or AI-driven components. Through systematic MAC-layer optimization on an on-premises Amarisoft 5G gNB, tuning Scheduling Request (SR) periodicity, the Time Division Duplex (TDD) uplink/downlink slot pattern, and fixed MAC timing parameters, the average RTT was reduced from 24 ms to 9 ms, a 62.5% improvement, with zero packet loss. A lightweight RTT-driven profile-switching mechanism was validated across more than 100 experimental runs. As a work-in-progress contribution, an AI-driven intent-based extension is further proposed, but not yet experimentally validated, in which a contextual reinforcement learning (RL) agent autonomously selects MAC-layer profiles based on application-level Quality of Experience (QoE) signals and network Key Performance Indicators (KPIs). Planned validation over the 6G-BRICKS Cell-Free Massive MIMO testbed at KU Leuven is outlined.

Keywords: extended reality; 5G; low latency; MAC-layer optimization; intent-based networking; reinforcement learning; emergency response; edge computing




RTT and DL/UL bitrate over time | Before Optimization
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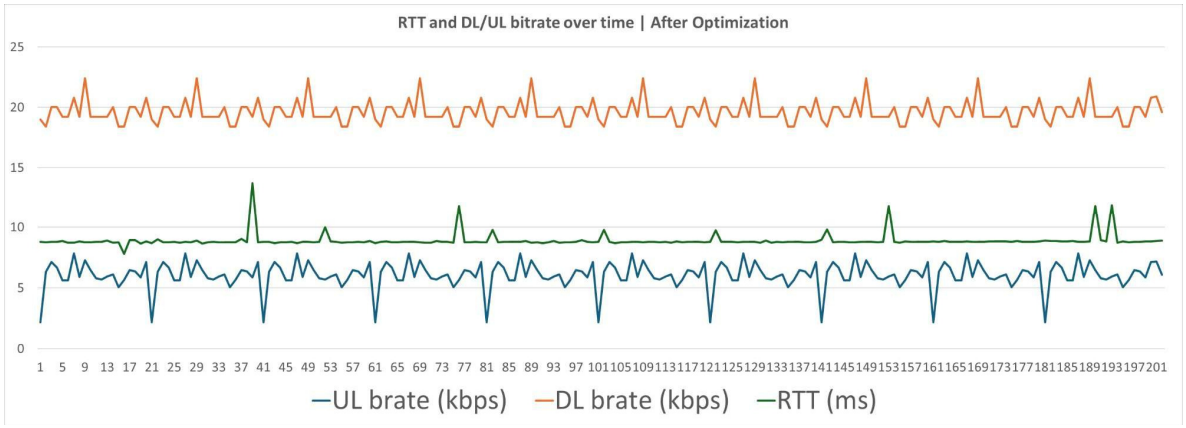
RTT and DL/UL bitrate over time | After Optimization
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RTT (ms)

Product-state manifolds for M quantum systems with N levels using the Fano form and the induced Euclidean metric

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Abstract

In quantum mechanics, separable states are defined as convex combinations of product states, whereas non-separable states exhibit entanglement. Quantum entanglement plays a crucial role in both theoretical investigations and practical applications of quantum information science. This study investigates the relationship between product states and geometric structures, specifically manifolds, and their associated geometric properties, such as the first fundamental form (metric). It focuses on manifolds that are formed by the product states of M systems with N levels and examines the induced metric derived from the Euclidean metric. The Levi–Civita connections are computed for elementary cases, and, where computationally feasible, the scalar curvature is determined. The findings reveal that the manifolds of product states possess a well-defined Riemannian structure, with negative scalar curvature obtained explicitly in two cases for which the curvature is evaluated in closed form. These characteristics provide a differential-geometric characterization of the product-state locus and offer new insights into its structure within the quantum state space. Since separable states are convex combinations of product states, extending this geometric approach to the convex hull of product states and investigating its possible role in separability detection constitute natural directions for future research.

Keywords: separable states; product states; entangled states; manifolds; surfaces, geometry; metric; curvature; Levi-Civita connection; quantum engineering

Nonlinear Modeling and Coordinated Control Strategies for Studying HVDC-connected RES/ESS to the Grid

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Abstract

Modern power systems involving High Voltage Direct Current (HVDC) transmission connecting the mainland-grid to Renewable Energy Sources (RESs), such as PV clusters, local AC loads and Energy Storage System (ESS) installations located near the RESs, have been extensively studied under novel coordinated control strategies. To investigate system stability and control, the accurate nonlinear dynamic model of the entire system is first deployed to avoid linear approximations that may affect the results. In the second stage, appropriate control schemes are applied to the AC/DC and DC/DC power interfaces, where some innovative assets are introduced to enable coordinated power regulation of the HVDC link transmission, simultaneously ensuring effective operating conditions for the ESS. System stability is established by demonstrating that Input-to-State Stability (ISS) is achieved. Theoretical analysis and extensive simulations show that the HVDC link control enables fast voltage regulation under severe weak-grid conditions on both AC sides of the HVDC link. Voltage and reactive power control effectively regulate the AC voltage profiles on both sides. The overall coordinated control scheme is integrated by achieving Maximum Power Point Tracking (MPPT) for the PV and improved cooperative power-sharing control between the HVDC link and the ESS, as implemented on the locally controlled AC/DC and both DC/DC converter interfaces, respectively.

Keywords: AC/DC power systems; nonlinear modeling; PV/ESS renewables; HVDC link; voltage/reactive power control

Scenario-Based People-Process-Technology Mapping for Social Engineering Awareness

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Abstract

Multi-channel social engineering attacks exploit individual decision-making while unfolding through organizational procedures and system interfaces. Prior work has examined user susceptibility, training, attack-channel evolution, and detection, but these strands are often weakly connected when interventions are designed or assessed. This paper presents a scenario-based People–Process–Technology (PPT) mapping model for multi-channel social engineering awareness. It uses a scenario as the starting point and links attack characteristics to weaknesses, intervention actions, and measurable criteria through an Identify–Model–Intervene–Evaluate–Adapt (IMIEA) cycle. A worked credential-harvesting use case illustrates the full cycle using one notional participant response, showing how an apparent internal IT password-reset message is mapped to PPT weaknesses, converted into expected secure actions, assessed through response measures, and used to derive adaptation actions. As a design artifact, the paper specifies mapping rules, secure-response measures, and evaluation logic for scenario-based assessment. The result is a structured basis for evaluating awareness as secure response quality across human-centered, organizational, and technology-supported dimensions.

Keywords: Social engineering; phishing; security awareness; People–Process–Technology; human factors; scenario-based evaluation; cybersecurity training

A Framework for Interactive Visualization and Evaluation of Classical Shortest-Path Algorithms in a Grid-Based Game

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Abstract

This paper presents the implementation and comparative evaluation of three classical shortest-path algorithms-Dijkstra, A*, and Bellman-Ford-within the Python/Pygame grid-based game environment PetWars. The developed framework provides a common environment for implementation, interactive visualization, and comparative benchmarking of the three algorithms under identical movement rules and map configurations. This common setup enables reproducible evaluation of path-finding behavior. The game models a 14 × 10 grid of walkable and blocked tiles, where movement is allowed in eight directions with weighted orthogonal and diagonal costs. The original PetWars map is used as an interactive demonstration environment. A dedicated demonstration mode visualizes the search process step by step by displaying the explored vertices, the frontier set, and the resulting shortest path. Performance is evaluated using five predefined routes and repeated measurements on two hardware configurations. Execution time, path cost, and the number of expanded vertices are analyzed under identical experimental conditions. The evaluated benchmark results agree with the theoretical characteristics of the evaluated algorithms. Within the implemented framework, A* explores fewer vertices and achieves the shortest execution times owing to heuristic guidance; Dijkstra examines a larger portion of the search space, whereas Bellman-Ford incurs the highest computational cost because of repeated edge relaxation. The developed application provides a common environment for benchmarking and visual demonstration of classical shortest-path algorithms.

Keywords: shortest-path algorithms; Dijkstra; A*; Bellman-Ford; grid-based games; pathfinding; algorithm visualization; Python; Pygame; educational software

A Results-Based Evaluation Framework for Smart Learning Environments: Use Cases, User Testing, and Validation Design of the OSEME Platform

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Abstract

Smart learning environments (SLEs) extend conventional learning management systems by adapting content delivery to the cognitive profile, prior knowledge, and behavioral patterns of individual learners. Although the technical realization of such systems is increasingly well documented, their empirical evaluation remains comparatively underdeveloped, and assessment efforts frequently rely on subjective impressions rather than reproducible measurement. This paper addresses that gap by proposing a results-based, tri-pivotal evaluation framework that unifies pedagogical, technological-usability, and learning-analytics dimensions into a single, database-grounded measurement model. The framework is instantiated on OSEME, an ontology-driven adaptive platform that integrates a Felder-Silverman learning-style profiler, a domain-knowledge assessment in Music History, and real-time analytics visualization within a modular PHP/MySQL architecture. To operationalize the framework, we specify formal use cases, a structured user-testing protocol with task-level success criteria, and a set of case-study designs, including a controlled A/B retention experiment and a System Usability Scale (SUS) assessment. Use cases, user tests, and case studies are presented in tabular form to support replication. The contribution is methodological: a transferable evaluation blueprint that converts platform telemetry into actionable evidence of pedagogical effectiveness, technical performance, and usability.

Keywords: smart learning environments; adaptive learning; felder–silverman model; learning analytics; usability evaluation; system usability scale; user testing; ontology-based personalization

Ethical Digital Marketing and Machine Learning: An Integrative Review and Human-Centered Conceptual Framework

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Abstract

Today, machine learning (ML) is the basis for digital marketing personalization, dynamic pricing, prediction, and automated targeting. This also presents ethical issues, such as transparency, fairness, privacy, and consumer autonomy. The study presents a structured literature review of ethical machine learning in digital marketing based on conceptual, empirical, and regulatory sources. The studies reviewed were divided into four categories: transparency and explainability; fairness and algorithmic bias; privacy and consumer autonomy; and accountability and oversight. The review suggests that ethical AI practices are associated with stronger consumer trust, engagement and brand legitimacy, but these relationships are conditional rather than universal: transparency strengthens trust when disclosures are comprehensible and proportionate, while intrusive or overly technical disclosures may increase concern. The synthesis produces a human-centric conceptual framework that links ethical AI practices to consumer-level mechanisms, marketing and societal outcomes, moderated by consumer AI literacy, data sensitivity, level of personalization, cultural context, and the regulatory environment. Four research propositions are suggested for future empirical testing. The proposed framework is a theoretical contribution to inform responsible, trustworthy, and human-centred AI-driven marketing.

Keywords: digital marketing; machine learning; ethics; AI transparency; consumer trust; transformative marketing

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Ethical Digital Marketing and Machine Learning

Shaping a responsible future for society

Alexios Kaponis · Manolis Maragoudakis
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The research problem

How can marketing teams balance innovation with ethical responsibility when deploying machine learning at scale?

A conceptual and integrative review. No new experiments are reported. The paper synthesises published empirical work — among others Patel (2020) and Zilbershtein et al. (2024) — within a frame that joins AI ethics to transformative marketing. Findings remain attributed to their original studies.

What machine learning already does

- **Personalised recommendation**
  The product surfaced before the search
- **Predictive analytics**
  Purchase and churn forecast from past behaviour
- **Sentiment analysis**
  Public feeling toward a brand, in near real time
- **Customer segmentation**
  One audience replaced by fine-grained niches
- **Automated ad targeting**
  The message placed at peak receptivity

Grewal et al. (2025); Ahmed et al. (2024)

Where the same tools turn against the consumer

- **Algorithmic bias**
  Historical prejudice in training data is reproduced, and often amplified, in who is targeted and who is charged more (Fu, 2024)
- **Erosion of privacy**
  Persistent tracking and predictive profiling hollow out informed consent (Bains & Gaidosch, 2025)
- **Manipulation**
  Once a model reads emotional state to push a purchase, marketing stops informing and starts exploiting
- **Opacity**
  Marketers often cannot explain their own systems' outputs — an AI Act exposure and a slow drain on trust (Floridi, 2019)

The rules are already written

The EU AI Act takes a risk-based approach: transparency duties, stricter requirements for high-risk systems, governance expectations for general-purpose models. It is phasing in over the coming years. In parallel the FTC treats omissions about data collection or model use as material misrepresentation.

European Commission (2024a); European Union (2024b); FTC (2024)

The evidence synthesised

Machine-learning text analytics

Ethical framing outperforms pressure framing

Influencer content across Instagram, Twitter and YouTube read with NLP, sentiment analysis and topic modelling, setting moral vocabulary against urgency vocabulary. Campaigns built on transparency drew warmer sentiment and steadier engagement than campaigns built on scarcity.

Patel et al. (2020); Huma (2024)

Transparency in targeted advertising

Advertisers overestimate their own transparency

Participants cast at random as viewers or advertisers in a simulated video-on-demand service, writing and judging explanations for targeted ads. Both roles picked similar data features; advertisers judged their own explanations clearer than viewers did.

People want explanation, and still refuse exposure

Participants set sensitive attributes aside, explaining targeting through neutral ones such as device type. Transparency is welcomed up to the point where it feels intrusive.

Zilbershtein et al. (2024)

What the evidence supports

- **Transparency converts into trust**
  Clear communication about how ML systems work, and how they protect user interests, raises trust and loyalty
- **Fairness reads as competence**
  Systems designed for fairness and explainability correlate with higher brand legitimacy (Hardcastle et al., 2025)
- **Framing matters**
  AI positioned as serving social good rather than persuasion draws stronger engagement and longer retention (Ledro et al., 2025)

Ethical integration is not a brake on innovation but the condition for trust-based consumer relationships.

Theoretical frame

Digital marketing ethics — the principles guiding how institutions collect, analyse and use consumer data (van Breda et al., 2023) — has outgrown its advertising-era concerns. Two literatures are joined here.

Algorithmic governance

Fairness, accountability, and transparency with explainability, as articulated by Floridi (2019) and Jobin et al. (2019), substantiated by Qian et al. (2024).

Transformative marketing

Zhanbayev et al. (2023) argue for moving beyond persuasive marketing toward marketing as an instrument of social change. Transformative Service Research contributes quality of life and equity; Transformative Consumer Research contributes empowerment and vulnerability.

Their intersection is this paper's contribution: responsible innovation that treats the AI Act's transparency and risk-assessment duties, and IEEE Ethically Aligned Design, as a floor rather than a finish line.

Three pillars for the transition

01 **Transparency.** Plain communication about data collection, algorithmic logic and decision-making — the cornerstone of consumer trust.

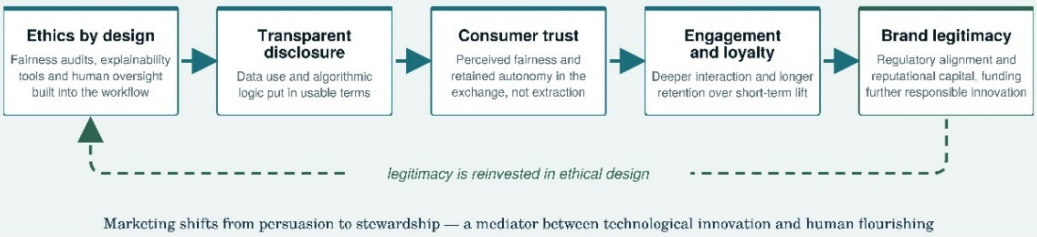
02 **Fairness.** Systems that avoid bias and represent audiences equitably in targeting and personalisation (Fu, 2024).

03 **Consumer autonomy.** Personalisation that informs rather than manipulates, keeping human agency intact (Zhanbayev et al., 2023).

Scope and limits

This is a synthesis, not a primary study. Every finding shown here belongs to the original design that produced it — most of them single-context and cross-sectional. What the paper contributes is the frame: AI ethics and transformative marketing read as one argument rather than two literatures.

Figure 1. The self-reinforcing cycle of ethical AI practice in marketing



Marketing shifts from persuasion to stewardship — a mediator between technological innovation and human flourishing

What this means in practice

- **Ethics by design:** checkpoints across the workflow, not a review at the end
- **Fairness audits and explainability tooling,** monitored continuously
- **Human in the loop:** retained oversight guards against algorithmic drift
- **AI literacy** across managerial and creative teams, ahead of the backlash
- **Governance indicators:** fairness and digital well-being beside conversion

Where the work goes next

Cross-cultural study of how consumers in different regions read ethical AI communication, given how sharply attitudes to transparency and privacy vary.

Longitudinal designs tracking how ethical marketing practice shapes digital trust and societal well-being over time, rather than at a single point of measurement.

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Full list in the proceedings paper, published in MDPI *Engineering Proceedings*.

Facial Identification and Attendance Infrastructure for Adaptive Smart Classrooms: An Edge Prototype and Open-Set Benchmark

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Abstract

This study presents a two-level evaluation of a smart-classroom attendance infrastructure that combines an embedded edge prototype with a separate open-set face-recognition benchmark. A Raspberry Pi 4 prototype was developed to integrate facial recognition, attendance registration, LCD feedback, and servo-based access simulation. Device-level testing comprised 20 access attempts under each of three controlled conditions. The prototype achieved end-to-end correct identification rates of 95.0% under standard indoor lighting and 85.0% under reduced lighting, with mean response times of 0.8 and 1.2 seconds, respectively. All 20 unknown-face attempts were correctly rejected, with a mean response time of 0.6 seconds. The dlib and SCRFD-ArcFace 1-NN pipelines were compared offline on a separate workstation using a custom open-set recognition protocol on the LFW-deepfunneled dataset. At the fixed, non-matched operating thresholds used in this study, SCRFD-ArcFace achieved 98.3% overall accuracy, a 96.7% true positive identification rate (TPIR), and a 0.4% false positive identification rate (FPIR), compared with 83.8%, 93.1%, and 23.3% for dlib, respectively. The main contribution is a clear distinction between the complete Raspberry Pi prototype tests and the algorithmic benchmarks conducted on a workstation. The prototype provides a basis for further development and validation of secure and automated educational environments, including systems intended to support learners with special educational needs.

Keywords: facial recognition; attendance registration; Raspberry Pi; edge computing; open-set identification; data protection; smart classroom; Internet of Things

Edge-AI-Based Multi-Modal Soil Organic Matter Estimation Using RGB, Spectral, and Munsell Color Representations

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Abstract

Accurate estimation of Soil Organic Matter (SOM) is essential for sustainable agricultural practices and precision farming. However, conventional laboratory-based analyses are costly, time-consuming, and require destructive sampling, limiting their applicability for frequent field measurements. Although machine learning approaches have demonstrated promising results for SOM prediction, many existing solutions rely on laboratory instruments or computational environments that limit their deployment in real-world agricultural scenarios. This paper presents a low-cost edge-AI framework for non-destructive SOM estimation based on a Raspberry Pi 5 platform. The proposed system integrates four complementary prediction models: a spectral ensemble model, an RGB image-based model, a Munsell colour-based model, and a hybrid RGB–Munsell model. The evaluation, performed on a dataset of 6,167 soil samples, showed the spectral ensemble model achieving the highest performance with an R^2 of 0.845, an MAE of 0.416% SOM, and an RPD of 2.54. A lightweight web interface enables image acquisition, data input, and local inference without requiring cloud connectivity. The framework addresses practical deployment challenges, including camera-based feature extraction, model compatibility, and execution on resource-constrained hardware. The implemented prototype demonstrates the feasibility of executing the complete SOM estimation pipeline entirely on an embedded platform, enabling portable and autonomous soil analysis.

Keywords: Soil Organic Matter estimation ; precision agriculture ; edge artificial intelligence ; machine learning ; RGB imaging ; soil spectroscopy ; Raspberry Pi

Experimental evaluation of BGO inorganic single-crystal scintillators with silicon photomultiplier (SiPM) photodetector

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Abstract

This study presents the experimental evaluation of inorganic single-crystal BGO scintillators using a gamma-ray photodetector, specifically the modern silicon photomultiplier (SiMP) PM3350 from KETEK. BGO scintillators of six sizes (3×3×5 mm^3, 3×3×10 mm^3, 3×3×15 mm^3, 3×3×20 mm^3, 3×3×25 mm^3 and 3×3×30mm^3) were optically coupled with the active area of the silicon photomultiplier. Energy spectra obtained from the irradiation of the radioactive source of Cesium-137 were acquired and digitized using a CAEN DT5720 desktop digitizer and subsequently analyzed through dedicated digital pulse – processing software. The evaluation of each gamma ray detector is focused on energy resolution under identical conditions. The best achieved energy resolution values were around 11% at 662 keV using the 3x3x5 mm^3 BGO scintillator crystal. For the rest of the BGO scintillators energy resolution values ranged between 12% and 16%. BGO scintillators have excellent stopping power and low cost making them attractive for medical imaging applications.

Keywords: BGO scintillators; Gamma-ray spectroscopy; Silicon photomultiplier

Invited Speech – Industry Perspective

Artificial Intelligence-Enabled Practice Management Software: Strategic and Clinical Implications for Healthcare Delivery in Australia and Europe

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Abstract

Artificial Intelligence (AI) is transforming healthcare by extending the role of Practice Management Software (PMS) beyond automation of clinical workflows towards intelligent clinical decision support. Traditionally, PMS has been used to schedule appointments, manage electronic health records, process insurance claims, issue electronic prescriptions, and facilitate communication between healthcare providers, laboratories, and patients. The emergence of AI and predictive analytics is enabling these systems to analyze large clinical datasets, identify treatment patterns and provide evidence-based insights that support clinicians without replacing professional judgement.

This paper examines how AI-enabled Practice Management Software contributes to improved patient outcomes and operational efficiency across healthcare systems in Australia, the United States, the United Kingdom and Europe. Particular emphasis is placed upon Assisted Reproductive Technology (ART), where AI-assisted embryo assessment demonstrates how machine learning can augment clinical decision-making through objective analysis of embryo viability, genetic testing results and developmental characteristics. The paper argues that PMS, as a particular type of enterprise software in the healthcare industry ('enterprise healthcare software'), is taking advantage of the opportunity to integrate clinical decision-support systems to improve healthcare delivery.

Keywords: artificial intelligence; practice management software; clinical decision support systems; assisted reproductive technology; enterprise software; healthcare informatics; machine learning; digital health; predictive analytics; electronic health records

Experimental evaluation of inorganic LGSO:Ce scintillators for applications in Medical Imaging

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Abstract

This study presents the experimental evaluation of inorganic mixed orthosilicate LGSO:Ce scintillators using the silicon photomultiplier (SiPM) PM3350 gamma-ray photodetector from KETEK. Four scintillators of these sizes ($3\times3\times5mm^3$, $3\times3\times6mm^3$, $3\times3\times10mm^3$ and $3\times3\times15mm^3$) where each individually optically coupled to the photodetector and characterized under three bias voltages (29V, 30V and 31V) using ^{137}Cs radioactive source. Energy spectra were acquired, digitized and analyzed using the CAEN DT5720 digitizer and a dedicated digital pulse processing software. The evaluation focused on energy resolution as a function of crystal length and bias voltage, quantum detection efficiency and linearity of response. The shortest crystals (5mm and 6mm) achieved the best energy resolution, 11% at 31V — confirmed as true optimum through additional measurements at 31.5V and 32V — comparing favorably with the literature values of 12-14%. The longer crystals (10mm and 15mm) exhibited higher quantum detection efficiency (QDE), reaching 0.62 for 15mm. Linearity measurements using ^{137}Cs, ^{60}Co and ^{133}Ba sources demonstrated a strong linear response across the tested energy range. Emission spectra and optical transmittance measurements, consistent with the literature values, further confirmed sample quality and reliability. These results indicate that LGSO:Ce, particularly in shorter crystal lengths, is a promising, cost-effective scintillator material for medical imaging applications.

Keywords: LGSO:Ce scintillators; gamma-ray spectroscopy; silicon photomultiplier

Comparative Evaluation of Various Inorganic Scintillation Crystals Coupled by a SiPM Detector in the Energy Range of 81keV up to 1333keV

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Abstract

This study presents the experimental evaluation of single-crystal scintillators such as NaI:Tl, CsI:Tl, CsI, BGO, LGSO:Ce, GAGG:Ce, and LFS-3, using the modern silicon photomultiplier (SiPM) PM3350 from KETEK. All crystals used in this study have dimensions equal to 3×3×5 mm^3 and were optically coupled with the photodetector. Energy spectra were produced after the irradiation by three closed radioactive sources (^{137}Cs, ^{133}Ba, and ^{60}Co). The acquisition and digitization of the pulses was conducted using a CAEN desktop digitizer (DT5720) and dedicated pulse processing software (DPP-CI firmware). The evaluation of the scintillation detectors focused on energy resolution and linearity parameters under identical conditions. The best achieved energy resolution values (approximate to 8% for Cs excitation) were recorded with the GAGG:Ce crystal, as expected, outperforming the rest of the scintillators. In some cases, scintillation crystals with lower light yield and density, such as pure CsI, weren't able to detect ^{60}Co photopeaks. Lutetium-based scintillators show excellent performance for nuclear medicine (PET detectors) while CsI:Tl and GAGG:Ce exhibit energy resolution values lower than 20% at energies used in SPECT detectors. This study showcases the capabilities of each of the scintillation crystals coupled with SiPMs, within the energy range of 81keV-1333keV.

Keywords: inorganic scintillators; NaI:Tl; CsI:Tl; BGO; GAGG:Ce; gamma-ray spectroscopy.

Smart Windows for Energy-Efficient Buildings: From Electrochromic to Self-Powered Photo-electrochromic Technologies

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Abstract

Addressing the global energy challenge requires urgent interventions in high-demand sectors, with the building sector remaining a primary contributor alongside transport and industry. Within the European Union, buildings account for roughly 40% of overall energy consumption and half of natural gas use, with approximately 80% of this energy allocated to space conditioning and domestic hot water. The use of smart windows can improve the energy performance of a building, by blocking the excess solar heat entering the building, thus reducing cooling needs, especially in the summer. Among the available smart windows technologies, Electrochromic Windows (ECWs) and Photo-electrochromic Windows (PECWs) are the only technology that provide dynamic control over visible light and solar heat transmission through a reversible, transparent-to-tinted phase transition, applying a low voltage. This study presents conventional ECWs, outlining their operational requirements and objectives. To overcome the key limitations of standard ECWs, we introduce PECWs at both small and large scales. This hybrid technology retains the benefits of ECWs while integrating a photovoltaic component, thereby eliminating the need for an external power supply. More importantly, PECWs can work autonomously, depending on the available irradiance levels. Thus, there is no need to use a controller, to drive their operation.

Keywords: energy saving; buildings; electrochromic; photo-electrochromic

Invited Speech

From Data to Meaning: Why Technology Needs Stories

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Abstract

What happens when technology knows more and more, while we find it increasingly difficult to understand what all this knowledge means?

Perhaps the answer is not more technology.

Perhaps it is: a better connection between technology and human experience. And this is where Digital Storytelling can play an important role.

Because:

AI can identify patterns.

Data Science can reveal structures.

GIS can represent space.

Computer Vision can analyze images.

Natural Language Processing can analyze language.

But:

Stories connect information with human experience.


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