Dokuz Eylül University
Graduate School of
Natural and Applied Sciences

DEUISGR2025

4th International Symposium on Graduate Research

ABSTRACT BOOK

17 - 19 December 2025
İzmir, TÜRKİYE

DEUISGR2025 - 4th International Symposium on Graduate Research

Abstract Book

Organized by
Dokuz Eylül University
Graduate School of Natural and Applied Sciences
İzmir, Türkiye

Symposium Dates
17–19 December 2025

Format
Online Symposium

Editors

Prof. Dr. Abdullah SEÇGİN
Prof. Dr. Sedat ÇAPAR
Assoc. Prof. Dr. K. Emrah ERGİNER

Publication Information

This abstract book includes the abstracts accepted for presentation at the
4th International Symposium on Graduate Research (DEUISGR 2025).

PREFACE

Graduate education and scientific inquiry constitute the foundation upon which universities generate knowledge, innovation, and societal impact. In this context, providing platforms where graduate researchers can share their work, exchange perspectives, and engage with the academic community is of vital importance. The International Symposium on Graduate Research (DEUISGR) was established with this vision in mind.

We are pleased to welcome you to the **Fourth International Online Symposium on Graduate Research (DEUISGR 2025)**, organized by Dokuz Eylül University. This symposium offers graduate students an international environment in which they can present their research outcomes, discuss emerging ideas, and interact with fellow researchers and experienced academics. It aims not only to highlight scholarly achievement, but also to encourage critical thinking, collaboration, and academic dialogue.

DEUISGR 2025 brings together contributions from a wide range of disciplines, including natural sciences, engineering, architecture and planning, as well as applied and interdisciplinary fields. The diversity of topics and approaches represented in this symposium reflects the dynamic nature of graduate research and the growing importance of interdisciplinary perspectives in addressing contemporary scientific and societal challenges.

We believe that this symposium serves as more than a venue for presentations. It is a space where academic connections are formed, ideas are refined, and future collaborations may emerge. By fostering an inclusive and interactive online environment, DEUISGR 2025 seeks to strengthen the sense of academic community among graduate researchers and scholars.

On behalf of the organizing committee, we would like to express our sincere appreciation to all contributors, reviewers, session chairs, and participants for their dedication and enthusiasm. We wish all participants a productive, engaging, and inspiring symposium.

Welcome to DEUISGR 2025.

Prof. Dr. Abdullah SEÇGİN
Chair, DEUISGR 2025

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Scientific Program

17 December 2025

09:45–10:00	**Opening Ceremony** **Prof. Dr. Abdullah Seçgin** *Director of the Graduate School of Natural and Applied Sciences*

A1 — James Watt Session

Session Chair: Prof. Dr. Şahin Yavuz

10:00–10:15	**Friction-Welded Two-Piece Sliding Yoke Design For Lightweight And Efficient Propeller Shaft Applications** *Mert Can Kahyalar*
10:15–10:30	**Investigation Of The Material-Dependent Performance Of The Side Door Impact Beam In Side Pole Impact Analysis** *Berkay Albuzlu, Murat Işık*
10:30–10:45	**AI-Assisted Decision Support Application For Categorization Of Propeller Shaft Bearing Damage** *Sedat Tarakçı, Efe Işık*
10:45–11:00	**Studies On Modeling And Control Of Suspension Systems In Tractors** *Gökçe Nur Yıldırım, Sinan Kılıçaslan*

A2 — John von Neumann Session

Session Chair: Prof. Dr. Şahin Yavuz

11:00–11:15	**Toward Early Bearing Fault Detection In Geothermal Power Plants With Unlabeled Data And Signal-Based Preprocessing** *Beyza Nur Büyükdemir, Enis Karaarslan, Özgür Tamer*
11:15–11:30	**Voice Based Programming Of Industrial Robots** *Ramazan Çoban, Ünal Dana, Aytuğ Onan, Levent Çetin*
11:30–11:45	**Evaluation Of Ergonomic Risk Factors In Catering Services** *Hatice Miray Sert, Ceren Şenyüz, Dilara Akcaalan, Mehmet Ali Özgöçmen, Esra Duygu Durmaz*
11:45–12:00	**Multi-Objective Optimization Of Low-Atmospheric Solid Propellant Rockets** *Barış Karataş, Utku Kanoğlu*

B1 — Vladimir Vernadsky Session

Session Chair: Prof. Dr. Mustafa Erol

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10:15–10:30	**Investigation Of Aging In Dental Nanocomposites** *Erkin Sezer, Haşim Fırat Karasu*
10:30–10:45	**Investigation Of Raw Material Locations For The Iraqi Cement Industry** *Omar Mohammed Shathar*
10:45–11:00	**Investigation Of Geophysical Gpr Measurements By Unmanned Aerial And Ground Vehicles** *Erkin Derya, Merve Rümeysa Güçlü, Seçil Turan Karaoğlan, Şahin Yavuz*

B2 — Alexander von Humboldt Session

Session Chair: Prof. Dr. Nurdan Büyükkamacı

11:00–11:15	**Calculation And Improvement Of Carbon Footprint For A Sustainable Environment** *Güldiyar Çetin, Hasan Selim*
11:15–11:30	**Synthesis And Application Of Cuo Nanoparticles For Toluene Capture In Complex Petroleum Wastewater Systems** *Imane Tiffour*
11:30–11:45	**Determination Of The Influence Of Temperature Variation On Index Value In The Cerchar Abrasiveness Test** *Şahin Güleryüz, Mehmet Volkan Özdoğan*
11:45–12:00	**Inspection And Evaluation Of Relevant Regulation Change Of Blast-Induced Ground Vibrations: A Case Study** *Mehmet Kılınç, Doğan Karakuş, Tuğçe Öngen*

Invited Speaker

13:00–14:00	**Prof. Dr. Özgür Çolpan**

A3 — Gustave Eiffel Session

Session Chair: Doç. Dr. Mert Yücel Yardımcı

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14:15–14:30	**The Assessment Of Long-Term Autogenous Shrinkage Of 3d Printable Fiber-Reinforced Concretes Containing Pozzolans** *Baraka Ciza, Çağlar Yalçınkaya, Ebru Kaya*
14:30–14:45	**Static Bending Analysis Of Timoshenko Beams On Pasternak Elastic Foundation** *Filiz Çetinkaya*
14:45–15:00	**Nonlinear Moment-Curvature Analysis Of Glued Laminated Timber Beams** *Hüseyin Kürşat Çelik, Gökhan Şakar*

A4 — Nikola Tesla Session

Session Chair: Prof. Dr. Yavuz Şenol

15:00–15:15	**Feasibility Study Of Low-Cost Photonic Sensors For Non-Destructive Surface Profile And Roughness Characterization** *Sonay Onur Avcı, Metin Sabuncu*
15:15–15:30	**Conceptual Design Of Gpr Mounted Unmanned Ground Vehicle Platform** *Ahmet Umut Güngörmüş, Tunahan Arslan, Seçil Turan Karaoğlan, Zülfikar Erhan, Mustafa Umut Karaoğlan*
15:30–15:45	**Comparative Performance Analysis Of Fast Analog To Digital Converter Architectures** *Gürcü Nur Ayas, Özge Cihanbeğendi*
15:45–16:00	**Spatio-Temporal Land Use And Land Cover Transformations Induced By The Akkuyu Nuclear Power Plant (2005–2025)** *Sema Ilgın, Alper Yalçın, G. Ecem Demirdağ*
16:00–16:15	**Hybrid Reinforcement Learning For Enemy Chase Decision-Making In Horror Games** *Isra Brahim, Yakup Çelikbilek*

B3 — Dmitri Mendeleev Session

Session Chair: Prof. Dr. Yoldaş Seki

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14:15–14:30	**Preparation, Characterization, And Antibacterial Efficacy Of Inclusion Complexes Containing Bay Essential Oil** *Çiğdem Özdemir, Ayşe Merih Sarıışık*
14:30–14:45	**Investigation Of Some Amide Compounds By X-Ray Diffraction And Quantum Mechanical Methods** *Emre Karademir, Arzu Karayel, Gülsüm Gündoğdu, Gülnihal Erten, Naki Çolak*
14:45–15:00	**The Green Synthesis Of Chitin And Chitosan And Its Biological Applications** *Büşra Arık, Nusret Ayyıldız, Abdulkadir Taşdemir*

B4 — Erwin Schrödinger Session

Session Chair: Prof. Dr. Resul Sevinçek

15:00–15:15	**Bio-Organic Semiconducting Thin Films: A Structural And Electronic Study** *Imane Tiffour*
15:15–15:30	**Machine Learning–assisted Separation Of Cherenkov And Scintillation Photons In Water-Based Liquid Scintillators** *Tuğçe Ayşegül Çelebi, Merve Taş, Dilara Kızılkaya, Muhammet Anıl Yağız, Mustafa Kandemir, Emrah Tıraş*
15:30–15:45	**Effects Of A Mediterranean Diet And Exercise Protocol On Glycaemic Parameters And Body Composition In Prediabetes: A Pilot Study** *Begüm Yücesoy Güneysu, Özgür Kasımay Berkoz, Elif Tuğçe Akın, Hasan Birol Çotuk*
15:45–16:00	**The Role Of Magnesium Biglycinate In Experimental Epilepsy And Its Interaction With Antiepileptic Drugs** *Burcu Sakioğlu, Abdulkadir Taşdemir*

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A5 — Ronald A. Fisher Session

Session Chair: Prof. Dr. Tuğba Yıldız

10:00–10:15	**An Alternative Data Balancing Approach To Improve Classification Performance On Imbalanced Data** *İhsan Karadeniz, Özlem Ege Oruç*
10:15–10:30	**Sign Language Letter Recognition And Performance Analysis Using Machine Learning Methods** *Ömer Çelikörs, Sedat Çapar*
10:30–10:45	**Color-Based Classification Of Fashion Outfit Images Using Artificial Neural Networks** *Nazlı Üren, A. Fırat Özdemir*
10:45–11:00	**Customer Segmentation With Machine Learning Algorithms** *Zehra Cünt, Tuğba Yıldız*

A6 — Karl Pearson Session

Session Chair: Prof. Dr. Tuğba Yıldız

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11:15–11:30	**Machine Learning Algorithms In Wi-Fi Networks** *Mustafa Ergun, Tuğba Yıldız*
11:30–11:45	**Cross-Attention Transformer Architectures For Drug–Target Affinity Prediction On Davis And Kiba Benchmarks** *Emre Altay, İdil Yavuz*
11:45–12:00	**Machine Learning Enhanced Career Guidance: Designing An Experience-Based Recommendation System** *Özgür Şeker, Engin Yıldıztepe*
12:00–12:15	**Predictive Maintenance Studies On Cnc Machine Tools** *Merve Karacan Kara, Tuğba Yıldız*

B5 — Jan Gehl Session

Session Chair: Prof. Dr. Hikmet Gökmen

10:00–10:15	**Fluid Standards: Measuring Aging And Spatial Analysis Methods** *Barış Acar*
10:15–10:30	**“Life In-Between”: A Conceptual Inquiry Into Common Areas In Buildings** *Elif Berra Kavuk, Fatma Süphan Somalı*
10:30–10:45	**Application Of Low-Tech In Architecture And Urban Life: Potential Uses In Aegean Region** *Onurcan Çakır*
10:45–11:00	**The Potential Of The Textile Waste As An Architectural Component** *Şevval Miray Görmüş, Feride Pınar Arabacıoğlu*

B6 — Mimar Sinan Session

Session Chair: Prof. Dr. Hikmet Gökmen

11:00–11:15	**Deciphering The Codes Of Mimar Sinan’s Design Evolution: A Comparative Analysis Of Apprenticeship, Journeyman, And Mastership Works Via Multi-Modal (Plan And Image) Artificial Intelligence Methods** *Enes Yalçınoğlu, Muhammet Kurucu*
11:15–11:30	**The Use Of Symbolic Decoration In Mimar Sinan's Bridges** *Zeyneb Çay, muhammet kurucu*
11:30–11:45	**Two Pinnacles Of The Central Plan: A Comparative Analysis Of The Spatial Organization And Structural Framework Of The Süleymaniye Mosque And St. Peter's Basilica** *Merve Ayaz, Muhammet Kurucu*
11:45–12:00	**An Evaluation Of The Historical Development Of Courtyards In Mosque Buildings During The Period Of Architect Sinan** *Serap Akkuş, Muhammet Kurucu*

Invited Speaker

13:00–14:00	**Prof. Dr. Yenal Akgün**

A7 — Patrick Geddes Session

Session Chair: Prof. Dr. K. Mert Çubukcu

14:00–14:15	**An Assessment About The Socio-Cultural Dimension Of Smart City Strategies** *Muharrem Duran, Damla Atik*
14:15–14:30	**Sustainable Urban Transformation Models** *Habsa Abdi Farah, Cevdet Emin Ekinci*
14:30–14:45	**Bibliometric Evaluation Of The Smart City Approach In The Context Of Landscape Architecture** *Bünyamin Aydınhan, Damla Atik*
14:45–15:00	**Spatial Plan Evaluation In Terms Of Climate Change: Insights From Türkiye And Other Countries** *Asya Kocabıyık, İlgi Atay Kaya*

A8 — Lewis Mumford Session

Session Chair: Prof. Dr. K. Mert Çubukcu

15:00–15:15	**Chrono-Tod: The 15-Minute City As The Missing Dimension In Transit-Oriented Development (Tod)** *Brian Bichanga Oburu, İlgi Atay Kaya*
15:15–15:30	**Error Or Discovery? The Spatial Value Of 'False Positive' Commercial Zones Detected By Machine Learning: The Case Of Izmir** *Delfin Günay Ercan, Kemal Mert Çubukçu*

B7 — Bill Hillier Session

Session Chair: Prof. Dr. Mine Tanaç Zeren

14:00–14:15	**Understanding The Multi-Layered Character Of An Archaeological Site: The Ancient City Of Stratonikeia** *Zeynep Simay Gümüşlü, Mine Tanaç Zeren*
14:15–14:30	**Periodical Analysis Of Spatial Design In Dedemli Village Traditional Houses With Space Syntax** *Raziye Çınar, Zafer Kuyrukçu*
14:30–14:45	**Analysis Of Üsküdar Mihrimah Sultan Madrasa And Edirnekapı Mihrimah Sultan Madrasa Using Space Syntax Method** *Ahmet Şamil Çankaya, Muhammet Kurucu*

14:45–15:00 **An Examination Of The Spatial Organization Of Mimar Sinan's Iconic Mosques And The Contemporary Çamlica Mosque Using Space Syntax**
Şeydanur Beroje, Muhammet Kurucu

B8 — Le Corbusier Session

Session Chair: Prof. Dr. Mine Tanaç Zeren

15:00–15:15 **The Transformation Of Tourism Architecture Typologies In Palm Jumeirah: Analysis Of Mega Resort Complexes, Lifestyle-Oriented Luxury Hotels And Boutique Luxury Properties**
Gökçe Demirpençe Özdoğan, İnci Uzun Mortan

15:15–15:30 **From Industry To Culture: A Comparative Study On Sustainability In Adaptive Reuse Of Industrial Heritage Projects**
Sude Yavuz, Dinçer Aydın

15:30–15:45 **Bibliometric Analysis Of User-Centred Approaches In Sustainable Facade Systems**
Neslihan Gül, Gizem İzmir Tunahan

15:45–16:00 **Discussion Of The Standardization Of Architecture Through The Government Offices**
Emine Yıldız Kuyrukçu, Mücahit Akbaş

19 December 2025

B9 — Louis Pasteur Session

Session Chair: Prof. Dr. Hülya Ayar Kayalı

10:00–10:15	**Stochastic Analysis Of Gene Expression Signals During Human Neuronal Differentiation Using Random Signal Processing Methods And Determination Of Signal Stability** *Rümeysa Karaismailoğlu*
10:15–10:30	**The Role Of Anatolian Sweetgum (Liquidambar Orientalis Mill) Oil In The Penicillin Model Of Epilepsy** *Aya Shakfah, Abdulkadir Taşdemir*
10:30–10:45	**Antiepileptic Activity Of Stem Cell-Derived Exosomes On Epilepsy** *Berfin Uğur, Abdulkadir Taşdemir*
10:45–11:00	**Investigation Of The Ubiquitin-Mediated Regulatoion Of Speedy/Ringo Protein In Hippocampal Neuronal Cells** *Selen Güneş, Ayşegül Yıldız*

B10 — Gregor Mendel Session

Session Chair: Prof. Dr. Hülya Ayar Kayalı

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11:15–11:30	**Integrated Crispr-Microfluidic Platform For Automated Point-Of-Care Pathogen Detection** *Md. Hafijur Rahman, Özge Cihanbeğendi*
11:30–11:45	**In Vitro Evaluation Of The Therapeutic Potential Of Gliquidone, A Type Ii Diabetes Drug, For Cancers Harboring Wild-Type P53 Through A Drug Repurposing Approach** *Elif Giçi, Ayşegül Yıldız*
11:45–12:00	**Integrative Analysis Of Single-Cell And Spatial Transcriptomics Data In Breast Cancer: A Comparative Deconvolution Approach** *Beste Uncu, İdil Yavuz*

Invited Speaker

13:00–14:00	**Prof. Dr. Levent Çavaş**

A11 — Vagn Walfrid Ekman Session

Session Chair: Doç .Dr. K. Emrah Erginer

14:00–14:15	**On The Dense Water Formation Of The Black Sea** *Bozkurt Burak Özhan, Şükrü Turan Beşiktepe*
14:15–14:30	**Physically Driven Uncertainty In Marine Ecosystems: Evidence From Entropy Dynamics In A Stochastic Npzd Framework** *Müjdat Aydın, Şükrü Turan Beşiktepe*
14:30–14:45	**Next-Generation Ultrasonic Inspection Technologies For Improving Hatch Cover Tightness Measurement Accuracy In Maritime Operations** *Karahan Karakurt, Kadir Emrah Erginer*

A12 — Alan Turing Session

Session Chair: Prof. Dr. Emel Kuruoğlu

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15:15–15:30	**Empirical Narrative Engineering: A Neuro-Symbolic Architecture For Structured Story Generation** *Mücahit Söylemez*
15:30–15:45	**Multi-Agent Authorization-Enabled Retrieval-Augmented Generation Framework** *Halil Yesil, Barış Tekin Tezel, Moharram Challenger*

B11 — Hippocrates Session

Session Chair: Prof. Dr. Özge Cihanbeğendi

14:00–14:15	**Integrating Real-Time Whole-Body Range Of Motion Assessment Into Telerehabilitation: A Computer Vision Approach For The Stepsmart AI Platform** *Asya Ası*
14:15–14:30	**Diagnostic Accuracy Of The Xpert MTB/XDR Assay For Detection Of Isoniazid And Second-Line Antituberculosis Drugs Resistance** *Ahmet Selman Mızraklıdağ, Deniz Gazel, Hatice Birgin*
14:30–14:45	**Development Of An Alginate-Based Biomaterial With Antibacterial Properties** *Erdem Bağseven, Nermin Seda Kehr*
14:45–15:00	**Design And Development Of A Syringe Pump System For Biomedical Microrobot Applications** *Kadri Emre Orgun, Levent Çetin, Mehmet Ersü, Serkan Doğanay*

B12 — Luigi Galvani Session

Session Chair: Prof. Dr. Özge Cihanbeğendi

15:00–15:15	**Clinical Superiority And Multimodal Applications Of CNT/PDMS-Based Flexible Piezoresistive Sensors** *Fatma Bayrakcı, Özge Cihanbeğendi*
15:15–15:30	**Screen-Printed Electrodes In Modern Electrochemical Biosensing: Materials, Materials, Modifications, Applications, And Future Directions** *Hezzal Küçükselbes, Özge Cihanbeğendi*
15:30–15:45	**A Portable Screen-Printed Electrode System For Ultra-Sensitive Salivary Serotonin Detection** *Hezzal Küçükselbes, Aleyna Yıldız, Fulya Yoldaş, Arda Yılmaz, Dilde Duru, Özge Cihanbeğendi*
15:45–16:00	**Synthetic EEG Signal Generation And Noise Integration: Validation Through Mathematical Modeling** *Elif Nur Selçuk, Mustafa Reşit Usal, Hatice Akman, Gökçenur Çakmak*

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FRICTION-WELDED TWO-PIECE SLIDING YOKE DESIGN FOR LIGHTWEIGHT AND EFFICIENT PROPELLER SHAFT APPLICATIONS

Mert Can Kahyalar

Tirsan Kardan San. Ve Tic. A.Ş.

Manisa,Yunus Emre, Türkiye

ORCID: 0000-0001-6826-5310

ABSTRACT

The propeller shaft is a critical power transmission component that transfers torque from the transmission to the differential while compensating for changes in length and angle induced by suspension movements. While angular variations are accommodated by the universal joint assembly—consisting of two yokes and a cross bearing—axial length changes are managed by the sliding group, which comprises a sliding yoke containing an internal female spline and a sliding shaft containing the corresponding male spline. As one of the key components of this system, the sliding yoke works in conjunction with the sliding shaft to enable extension–retraction motion through the spline connection while simultaneously transmitting angular motion via the universal joint.

In the conventional manufacturing method, the sliding yoke is produced as a monoblock forged part, and the cavity in the spline region is machined, resulting in substantial material waste and extended processing time. In this study, the sliding yoke was redesigned as a two-piece structure, where the fork section and the spline section were manufactured separately and joined using friction welding. This redesign not only offered a significant weight advantage but also improved overall production efficiency. To prevent the welding flash from interfering with the free motion of the spline, a dedicated groove geometry was developed. This feature enabled controlled flash displacement and ensured that spline functionality was fully preserved.

For the redesigned concept, the sliding shaft assembly design was frozen using iterative analysis with finite element method.

Subsequently, the fork and thick-walled tube were machined, and the friction welding process was performed. After welding, the external flash was removed while the internal flash remained confined within the specially designed groove. Hardness measurements were conducted on samples taken from the weld region to verify metallurgical inspections. Upon obtaining acceptable results, the complete propeller shaft assembly was manufactured and subjected to structural tests.

In parallel, the existing monoblock forged sliding yoke design was also analyzed using FEA and validated through structural testing. Comparative evaluation demonstrated that the two-piece friction-welded design achieved strength performance comparable to the conventional forged structure, while offering improvements in manufacturability, efficiency, and weight reduction.

As a result, the proposed manufacturing approach enables the sliding group of the propeller shaft to be produced in a lighter, more efficient, and equally reliable manner.

Keywords: Sliding Yoke, Friction Welding, Two-Piece Design, Finite Element Analysis (FEA), Manufacturing Optimization

INVESTIGATION OF THE MATERIAL-DEPENDENT PERFORMANCE OF THE SIDE DOOR IMPACT BEAM IN SIDE POLE IMPACT ANALYSIS

Berkay Albuzlu

Automotive Engineering,Uludağ University

Bursa, Türkiye

ORCID: 0009-0008-5664-1313

Murat Işık

Automotive Engineering,Uludağ University

Bursa, Türkiye

ORCID: 0000-0002-6116-1882

ABSTRACT

The optimization of passive safety systems within the automotive engineering domain holds critical importance due to rising global standards and the imperative for lightweighting. In this context, side door protection beams (side door impact beams), integrated into the vehicle architecture, play a vital role in effectively damping external energy during lateral collisions and thereby minimizing deformation, which is essential for ensuring passenger safety. The performance of these components is directly related to the dynamic behavior of the chosen material under impact and the decisive influence of the applied production method on the resulting mechanical properties.

This research presents a numerical comparison of the side door protection bar, using two different materials associated with distinct manufacturing methods. The comparison is conducted between 22MnB5 steel, which is produced using the challenging hot stamping method to achieve ultra-high strength through thermal processing, and Fortiform 1050 (3rd Generation Advanced High-Strength Steel - 3rd Gen AHSS), which is produced using the conventional cold forming method, known for its high formability and cycle time efficiency.

The side door beam geometry was created through reverse engineering from scanning data, resulting in a surface model in a 3D CAD environment. Subsequently, a side impact analysis was performed using the LS-DYNA pre- and post-processor. The side impact analysis was conducted based on the FMVSS 214 standard. To ensure the realistic modeling of material behavior, the accuracy of the material cards was verified using stress-strain data obtained from uniaxial tensile tests performed on the Fortiform 1050 steel, conducted according to the DIN-EN ISO 6892-1 standard.

The primary scientific contribution of this research is not limited merely to the numerical determination of the quantitative effects of different materials on critical safety performance metrics, such as maximum intrusion, energy absorption capability, and acceleration response. Furthermore, the structural performance findings are directly correlated with the differences in manufacturing methods and their influence on producibility. The results aim to provide a robust scientific foundation for engineering design decisions by balancing the significant producibility and cycle time efficiency advantages offered by the cold forming of Fortiform 1050 against the superior ultimate strength achieved by the hot stamping of 22MnB5. This comparison is critical for enabling the contemporary automotive industry to meet the strictest safety requirements while sustaining cost-effective lightweighting goals.

Keywords: Side impact analysis, impact beam, modeling, analysis, pole impact analysis

AI-ASSISTED DECISION SUPPORT APPLICATION FOR CATEGORIZATION OF PROPELLER SHAFT BEARING DAMAGE

Sedat Tarakçı

Tirsan Kardan A.Ş, Tirsan Kardan ArGe Merkezi

Manisa, Türkiye

ORCID: 0000-0002-9125-5919

Efe Işık

Tirsan Kardan A.Ş, Tirsan Kardan ArGe Merkezi

Manisa, Türkiye

ABSTRACT

The propeller shaft is a critical power transmission component responsible for delivering torque and rotational motion from the engine to the differential while compensating for length and angle variations caused by suspension movements. The bearings and trunnion surfaces located within the propeller shaft play an essential role in transmitting torque and rotational motion. These components are exposed to various types of damage over time—such as wear, cracks, surface deformation, and fractures—depending on operating conditions. Early detection of such damage is crucial for maintaining system performance and preventing safety-critical failures. However, traditional inspection methods rely largely on manual observation and operator experience, making the process time-consuming and prone to human error. Recent advances in image processing and artificial intelligence offer automated and highly accurate solutions for such industrial challenges.

In this study, an AI-assisted image processing system has been developed to automatically categorize universal joint features in order detect damge occurring on universal joints. The dataset used in the study was compiled from two primary sources. The first source consists of images extracted from Dynamic Durability Test (DDT) reports conducted at the Tirsan Cardan Test Center, using a custom software developed with Python and OpenPyXL. Initially, 5001 images were collected, which were reduced to 2229 after removing irrelevant regions. The second source includes high-resolution supplementary photographs obtained through a specially designed in-house imaging setup. This approach mitigated data imbalance and ensured greater variability for each damage class.

The developed system is intended to operate in a two-stage structure. The first stage—described in this study—uses the “CategorySense” model to determine whether the input image belongs to the trunnion journal surface, trunnion face surface, or yoke hole surface. In future work, the second stage will involve “DamageSense” models trained separately for each surface type to classify the damage severity. Due to class imbalance, the original ten-level grading scale will be reduced to four categories: very poor, poor, good, and very good. The CNN-based CategorySense model achieved a 100% F1 score on test data, demonstrating highly successful performance.

The results show that the proposed AI-based architecture provides a fast, objective, and accurate method for categorizing damage in propeller shaft joints, offering a strong alternative to traditional inspection approaches. This study contributes to the automation of damage analysis processes in the automotive industry by presenting a practical and scalable solution for preprocessing and grouping relevant visual data.

Keywords: Damage and wear in bearings, Image processing, Artificial intelligence (AI), Deep learning, Damage classification

STUDIES ON MODELING AND CONTROL OF SUSPENSION SYSTEMS IN TRACTORS

Gökçe Nur Yıldırım

Gazi University, Graduate School of Natural and Applied Science, Department of Mechanical Engineering,

06500, Yenimahalle, Ankara, Türkiye

ORCID: 0000-0002-6977-2039

Sinan Kılıçaslan

Gazi University, Faculty of Engineering, Department of Mechanical Engineering,

06570, Maltepe, Ankara, Türkiye

ORCID: 0000-0002-6535-9407

ABSTRACT

This paper examines the current state of suspension technologies for agricultural tractors, analysing various control methodologies and their effectiveness in improving ride comfort and vehicle handling. Conventional primary agricultural tractors have no suspension systems, resulting in significantly lower ride comfort compared to passenger vehicles. Since the usage of suspension systems in tractors improves the ride comfort and dynamic behaviour of them, modern agricultural tractors are equipped with different suspension systems such as seat, cabin, or chassis suspension.

The reviewed literature demonstrates that many researchers have developed various types of suspension for tractors. However, the efficiency of the passive suspensions is limited, and the idea of active systems is considered nowadays with the aim of improving the performance of vehicle's suspensions. Semi-active suspension systems emerge as a practical solution, where according to working principles of semi-active suspension, two acceleration sensors installed on the body acquire motion signal of the body and send it to electronic control unit (ECU). Then ECU drives a motor to adjust the throttle opening size of an absorber to change the damping coefficient. Hydro-pneumatic mechanisms represent a prominent approach, with studies developing hydro-pneumatic suspension models with semi-active suspension control. Additionally, magnetorheological (MR) damper technology has been investigated, where a MR-damper is made of MR fluid, which is made up of carbonyl iron powder and silicon oil.

The literature reveals diverse control strategies for semi-active suspension systems. Linear Quadratic Gaussian (LQG) optimal control algorithms have been extensively studied, with researchers designing LQG optimal control algorithms as semi-active suspension control algorithms. The rear suspension deflection was represented by Kalman-filter-based state observer feedback to estimate the state variables that were difficult to measure. Proportional Integral Derivative (PID) control approaches have also been implemented, where two objective functions are proposed to represent the handling stability and ride comfort, which are controlled through different PID feedback control modes. Skyhook control strategies represent another significant approach, with on-off skyhook selected as the control strategy for semi-active systems.

The reviewed studies employ comprehensive evaluation approaches combining simulation and experimental testing. In order to verify the characteristic of the semiactive suspension, a 7-degree-of-freedom model of vehicle was built based on full-vehicle dynamic system. The ride comfort in accordance with ISO 2631 is evaluated by comparing a vehicle with a passive cab suspension to that with a hydro-pneumatic suspension applied with the semi-active control. The surveyed literature consistently demonstrates a superior performance of semi-active systems over passive alternatives.

Keywords: Agricultural Tractors, Suspension Systems, Control Algorithms, Ride Comfort

TOWARD EARLY BEARING FAULT DETECTION IN GEOTHERMAL POWER PLANTS WITH UNLABELED DATA AND SIGNAL-BASED PREPROCESSING

Beyza Nur Büyükdemir

Department of Artificial Intelligence, Muğla Sıtkı Koçman University

Muğla, Türkiye

ORCID: 0009-0004-3046-4321

Enis Karaarslan

Department of Artificial Intelligence, Muğla Sıtkı Koçman University

Muğla, Türkiye

ORCID: 0000-0002-3595-8783

Özgür Tamer

Department of Electronic Engineering, Dokuz Eylül University

Izmir, Türkiye

ORCID:0000-0002-5776-6627

ABSTRACT

In geothermal power plants, generator bearings operate under continuous vibration and significant mechanical loads, making early fault detection critical for operational reliability and cost-effective maintenance. However, in many real-world applications, available vibration datasets are unlabeled, and the boundaries between normal and abnormal operating conditions are not clearly defined. This lack of labeling significantly complicates direct fault diagnosis and necessitates an initial exploratory analysis to better understand the intrinsic characteristics of the data.

In this study, a preliminary signal-based investigation is conducted on vibration data collected from generator bearings in a geothermal power plant. To improve signal quality and reduce the influence of noise and long-term trends, band-pass filtering and detrending are first applied as preprocessing steps. Subsequently, fundamental time-domain statistical features, including mean value, root mean square (RMS), and peak-to-peak amplitude, are extracted to characterize overall vibration behavior. In addition to time-domain analysis, Fast Fourier Transform (FFT) is employed to examine the dominant frequency components of the vibration signals and to gain insight into their spectral structure.

The initial results demonstrate that the applied preprocessing techniques effectively simplify the vibration signals and enhance their interpretability, allowing clearer observation of general vibration patterns within the unlabeled dataset. These findings establish a necessary foundation for subsequent stages of analysis. Future work will focus on extending feature extraction to more advanced indicators, applying statistical thresholding and anomaly detection approaches, and developing predictive maintenance frameworks using suitable data-driven models for early bearing fault detection.

Keywords: Geothermal power plants, vibration analysis, bearing condition monitoring, signal preprocessing, fast fourier transform (FFT)

VOICE BASED PROGRAMMING OF INDUSTRIAL ROBOTS

Ramazan Çoban

Graduate School of Natural and Applied Sciences, Department of Robotics Engineering, Izmir Katip Çelebi University

Çiğli, İzmir, Türkiye

ORCID: 0009-0004-0475-8713

Ünal Dana

Department of Mechatronics Engineering, Izmir Katip Çelebi University

Çiğli, İzmir, Türkiye

ORCID: 0009-0000-0776-1804

Aytuğ Onan

Department of Computer Engineering, Izmir Institute of Technology

Urla, İzmir, Türkiye

ORCID: 0000-0002-9434-5880

Levent Çetin

Department of Mechatronics Engineering, Izmir Katip Çelebi University

Çiğli, İzmir, Türkiye

ORCID: 0000-0002-7041-0529

ABSTRACT

In recent years, industrial robots have provided significant advantages over human labor in tasks that require high speed, precision, and continuity. With the increasing adoption of robotic systems, the programming and usability of robots have become critically important. Traditional robot programming methods are often complex, time-consuming, and require expert knowledge. In this study, a voice-based robot programming system is proposed to reduce these limitations and improve human–robot interaction. In the proposed system, predefined voice commands are detected using a keyword spotting approach and processed on the robot side through two different methods. In the first method, the recognized commands are transmitted to the robot in real time via the Robot Operating System (ROS), enabling immediate motion of the robot based on the tool frame reference. This approach allows the operator to control the robot's position, orientation, and motion parameters intuitively through voice commands. In the second method, instead of directly moving the robot, the recognized voice commands are converted into motion parameters and stored within a program structure. These parameters are then transformed into robot motion commands compatible with the robot programming language and executed offline or semi-offline on the robot controller. By combining these two methods, the proposed system provides both an interactive teaching interface and the capability to generate reusable robot programs through voice commands. In order to achieve this proposed system first the suitable keyword spotting method should be chosen. For this purpose, in this study, some of the chosen keywords (up, down, left, right, one, two, etc.) are tested with different keyword spotting methods. In future work the most suitable keyword spotting methods chosen in this study will be used to achieve the proposed system.

Keywords: Voice-Based Robot Programming, Keyword Spotting, Human–Robot Interaction, Robot Programming

EVALUATION OF ERGONOMIC RISK FACTORS IN CATERING SERVICES

Hatice Miray Sert

Industrial Engineering Department, İzmir Bakırçay University

İzmir, Türkiye

ORCID: 0009-0007-3548-7954

Ceren Şenyüz

Industrial Engineering Department, İzmir Bakırçay University

İzmir, Türkiye

ORCID: 0009-0003-1982-603X

Dilara Akcaalan

Industrial Engineering Department, İzmir Bakırçay University

İzmir, Türkiye

ORCID: 0009-0007-6271-0031

Mehmet Ali Özgöçmen

Industrial Engineering Department, İzmir Bakırçay University

İzmir, Türkiye

ORCID: 0009-0003-5008-7343

Esra Duygu Durmaz

Industrial Engineering Department, İzmir Bakırçay University

İzmir, Türkiye

ORCID:0000-0002-8882-333X

ABSTRACT

Work-related Musculoskeletal Disorders are one of the most significant occupational health concerns in labor-intensive service industries. The catering industry is heavily labor-intensive with limited automation, making it a critical area for occupational health risks. In catering and cafeteria operations, employees are frequently exposed to physical risk factors such as poor working postures, repetitive upper limb movements, prolonged static standing, and manual handling of heavy materials and loads. These ergonomic inefficiencies not only affect worker health but also reduce operational productivity and service quality.

This study aims to perform a multi-methodological ergonomic risk assessment in a university cafeteria to assess staff exposure to environmental and physical hazards in critical operational zones. A hybrid assessment framework that combined postural analysis, and environmental risk assessment was used to capture the complexity of the working environment.

The study examined body postures during food preparation, serving, and cleaning using the Rapid Entire Body Assessment (REBA). Additionally, NIOSH lifting equation was employed to analyze lifting tasks and physical loads to address the risks related to manual handling. According to postural analyses, workers in the kitchen are at high risk, which calls for quick action. According to the manual handling assessments, current operational procedures often go beyond advised safety limits, putting workers under biomechanical strain. Furthermore, certain workstations, were found to have inadequate lighting for safe and effective operation. The study suggests a set of controls based on these findings, including redesigning lighting systems, the implementation of height-adjustable equipment and mechanical handling aids. This study is supported under the TÜBİTAK 2209-A University Student Research Projects Support Program with project number 1919B012471626.

Keywords: Ergonomic Risk Assessment, Catering Services, REBA

MULTI-OBJECTIVE OPTIMIZATION OF LOW-ATMOSPHERIC SOLID PROPELLANT ROCKETS

Barış Karataş

Aerospace Engineering, Dokuz Eylül University

İzmir, Buca, Türkiye

ORCID: 0009-0001-2882-2618

Utku Kanoğlu

Aerospace Engineering, Dokuz Eylül University

İzmir, Buca, Türkiye

ORCID: 0000-0002-5952-0954

ABSTRACT

The design of solid propellant rocket motors and airframes presents a complex, coupled engineering challenge characterized by inherently contradictory performance requirements. This study presents a computational framework for optimizing contradictory metrics of a single-stage low-atmospheric rocket using the Multi-Objective Optimization approach with the Non-dominated Sorting Genetic Algorithm II. The proposed tool automates the trade-off analysis among three competing objectives: maximizing apogee altitude, minimizing ascent time, and maximizing payload mass. The optimization explores a multi-dimensional design space encompassing critical variables across propulsion, aerodynamics, and structural subsystems. The algorithm yields a 3D Pareto optimal set, revealing distinct performance clusters categorized as High-Altitude Specialists, Heavy Lift Configurations, and Fast-Response Interceptors. These results provide clear trade-off curves, enabling mission planners to select designs tailored to specific flight profiles from a mathematically optimal set of designs. Furthermore, by visualizing the physical dimensions and operating parameters of top-performing solutions, this study facilitates the reverse engineering of design specifications ideally suited for distinct mission categories.

Keywords: Multi-Objective Optimization, Solid Propellant Rocket, Genetic Algorithm, Conceptual Design

SURFACE TREATMENT STRATEGIES FOR CHICKEN FEATHER FIBER COMPOSITES: A REVIEW OF CURRENT APPROACHES AND CHALLENGES

Merve Güneri

Department of Architecture, Dokuz Eylul University

Izmir, Turkiye

ORCID: 0000-0002-8289-9181

Ahmet Vefa Orhon

Department of Architecture, Dokuz Eylul University

Izmir, Turkiye

ORCID: 0000-0003-2465-1951

ABSTRACT

The conversion of abundant waste streams into value-added products is a critical component of sustainable development and a core tenet of the circular economy. Chicken feathers, a keratinous by-product of the poultry industry, are emerging as a promising reinforcement for polymeric materials. Their inherent low density and hierarchical structure make them a compelling candidate for lightweight composites. This review systematically analyzes the scientific literature on the use of chicken feather fibers (CFF) in polymer composites, focusing on principal challenges and engineering solutions. The analysis demonstrates that the primary obstacle remains the interfacial incompatibility between the hydrophilic nature of keratin fibers —rich in amino acids and hydroxyl groups— and the hydrophobic character of most commercial polymer matrices. This thermodynamic mismatch prevents effective wetting of the fiber surface by the polymer melt, leading to the formation of voids that act as stress concentration points, which critically impairs composite performance.

To overcome this limitation, a range of surface treatments has been systematically investigated. Strategies range from physical modifications, such as alkali (NaOH) treatment which removes surface impurities and increases surface roughness for mechanical interlocking, to chemical coupling using agents such as silanes or maleic anhydride-grafted compatibilizers that function by creating a molecular bridge between the fiber and the matrix. The efficacy of these strategies, however, is strongly contingent on the selected polymer system and frequently results in performance trade-offs. For instance, enhancements in tensile and flexural properties are often achieved at the expense of other critical parameters like material toughness. This reduction occurs because the restricted mobility of polymer chains at the rigidified interface limits the composite's ability to absorb energy during impact. Such trade-offs limit their practical, cost-effective application.

This study reveals that the vast majority of existing research has concentrated on optimizing fundamental mechanical properties. Consequently, a significant research gap persists regarding functional performance metrics imperative for real-world applications, particularly in the construction and automotive sectors. These neglected areas include long-term durability, fire safety, and acoustic and thermal insulation performance. Therefore, to successfully transition CFF from an animal waste by-product to a high-value resource, it is posited that future research must pivot from single-property optimization towards a holistic, multi-functional material design paradigm that incorporates rigorous life-cycle and cost-benefit analyses.

Keywords: Chicken Feather Fiber (CFF), Biocomposites, Surface Treatment, Waste Valorization, Circular Economy

INVESTIGATION OF AGING IN DENTAL NANOCOMPOSITES

Erkin Sezer

Dokuz Eylul University

Izmir, Türkiye

ORCID: 0009-0004-8499-4280

Haşim Fırat Karasu

Dokuz Eylul University

Izmir, Türkiye

ORCID: 0000-0001-7129-4171

ABSTRACT

The structure and functions of dental tissue have a decisive impact on individuals' overall quality of life. Material loss resulting from dental caries adversely affects both the mechanical strength and the aesthetic appearance of the tooth, thereby necessitating restorative treatments. Today, composite resin–based restorative materials have largely replaced amalgam fillings. With advancements in filler particle size, nanocomposites containing nanoscale fillers have been developed, offering significant advantages in terms of aesthetics, mechanical strength, and wear resistance.

This study aims to investigate how the mechanical properties of nanohybrid composites with three different nanofiller ratios change before and after accelerated aging. The commercial products Optishade, 3M Z550, and Grandio were used in the study. The specimens were prepared in Teflon molds produced via 3D printing in accordance with international standards and were polymerized using an LED light-curing device according to the manufacturers' specifications. A total of 108 control and aged specimens were produced. Mechanical evaluations were conducted using compressive strength testing, three-point flexural strength testing, and Vickers microhardness testing. The compressive strength test measures the material's resistance to fracture under uniaxial loading, while the flexural test determines the strength developed when a load is applied between two support points. Vickers hardness measurements provide insight into surface resistance and the microstructural integrity of the material.

For the aging procedure, an artificial saliva solution compliant with the DIN 53160-1 standard was used. The specimens were exposed to an accelerated aging cycle for 7 days at 37 °C and 95–100% relative humidity in an Ascott CC1000ip chamber. This protocol simulates the chemical and thermal effects of the intraoral environment under laboratory conditions. Mechanical tests on the control group specimens have been completed, and testing of the aged specimens has commenced. By comparing the results, the effects of filler ratio and nanoscale particles on resistance to aging will be assessed. This will enable a more comprehensive understanding of how moisture, temperature, and chemical factors encountered in clinical conditions influence the performance of composite restorations.

The findings obtained from this study are expected to contribute to the evaluation of the long-term durability of nanohybrid composites and to strengthen the scientific basis for the selection of dental restorative materials.

Keywords: Nano-fillers, accelerated aging, Vickers microhardness, polymer matrix composites, artificial saliva environment

INVESTIGATION OF RAW MATERIAL LOCATIONS FOR THE IRAQI CEMENT INDUSTRY

Omar Mohammed Shathar

Slah AL Deen Municipalities

Slah AL Deen,iraq

ABSTRACT

Iraq's cement industry relies on substantial local mineral reserves, with limestone being the most critical component. The country possesses approximately 8 billion metric tons of high-quality limestone reserves, primarily concentrated in northern and central regions, including the Kurdistan Region (Sulaymaniyah), Nineveh, and Najaf provinces. The strategic proximity of these deposits to production facilities significantly enhances industry efficiency and reduces transportation costs.

Major cement complexes such as Bazian, Badoosh, and Kufa are strategically located near their respective quarries, creating integrated and cost-effective production centers. This geographical advantage contributes substantially to the operational efficiency of Iraq's cement manufacturing sector.

Clay and marl are abundantly available throughout Iraq, sourced from various geological formations, including Injana, Shiranish, and Euphrates formations. These materials provide essential silica, alumina, and iron oxide required for cement production. Conveniently, clay and marl quarries are often located near limestone deposits, further optimizing extraction operations.

Gypsum, crucial for controlling cement setting time, is primarily extracted from deposits in northern and central Iraq, particularly the Fatha and Jerkus formations. This mineral serves as an essential additive in the final cement composition.

For iron-bearing additives, the industry uses lateritic clay and industrial by-products, such as steel dust, as sources of iron oxide, rather than relying on direct iron ore mining, despite the presence of iron reserves in Najaf province.

The geographic distribution shows that northern and central Iraq host many cement plants, thanks to abundant raw materials. At the same time, southern Iraq relies on transportation and imports due to limited local resources. The strategic exploitation of these geological assets remains crucial for the success and growth of Iraq's cement industry, positioning the country as a significant regional cement producer.

Keywords: Limestone, clay, gypsum, Iraq's cement industry

INVESTIGATION OF GEOPHYSICAL GPR MEASUREMENTS BY UNMANNED AERIAL AND GROUND VEHICLES

Erkin Derya

Department of Mechanical Engineering, Dokuz Eylul Univesity

İzmir, Türkiye

ORCID: 0009-0002-7393-6355

Merve Rümeysa Güçlü

Department of Geophysics Engineering, Dokuz Eylul Univesity

İzmir, Türkiye

ORCID: 0009-0005-7201-7623

Seçil Turan Karaoğlan

Department of Geophysics Engineering, Dokuz Eylul Univesity

İzmir, Türkiye

ORCID: 0000-0002-3871-4792

Şahin Yavuz

Department of Mechanical Engineering, Dokuz Eylul Univesity

İzmir, Türkiye

ORCID: 0000-0001-9007-772X

ABSTRACT

Recent advances in geophysical technologies such as Ground Penetrating Radar (GPR), have increased the interest of using it with an unmanned ground and aerial vehicles for the exploration studies in geophysics. This presentation explains the role of unmanned ground vehicles (UGV's) and unmanned aerial vehicles (UAV's) in geophysical research with GPR. The swift development of radar systems, positioning techniques, and autonomous navigation has enabled the use of GPR more efficiently in environmental, geological and archeological investigations.

Ground-based techniques provide high-resolution data with easier sensor-surface coupling, which can be defined as efficient and effective for detection of the targets. These systems are widely preferred in applications of utility detection, archaeological investigations, road and pipeline inspection, and near-surface geological mapping. The direct contact between the antenna and the ground surface allows stronger signal acquisition, higher penetration depth, and clearer responses. However, their efficiency decreases through rough and hazardous surfaces such as steep slopes, glacier surfaces, debris-covered terrains, and unstable grounds. Manual or vehicle-based surveys become difficult and potentially dangerous for operators in these ground conditions. On the other hand, aerial vehicles such as drones allow faster coverage of the track, safer data acquisition, improved operation flexibility in inaccessible terrains. However, the increased distance between GPR and ground surface caused reduced signal clarity. This distance weakens the radar signal depending on the lower penetration depth. Therefore, reduced resolution is observed in the explorations with UAVs compared to the ground-based systems.

Unmanned vehicle-based GPR systems have become an important alternative to conventional survey techniques. This study aims to compare the application of GPR using UAV and UGV for data quality, surveying efficiency, field safety with discussing their major advantages in modern geophysical investigations. As a result, GPR applications using UGV provide high-resolution and better performance in shallow surface imaging. GPR applications using UAV also provide advantages for accessibility, safety, and rapid data acquisition. Therefore, the integration of GPR into the unmanned ground and aerial platforms can be expected to play a key role in the future of geophysical survey with GPR.

Keywords: Ground Penetrating Radar, Unmanned Ground Vehicle, Unmanned Aerial Vehicle, Geophysical Surveying

CALCULATION AND IMPROVEMENT OF CARBON FOOTPRINT FOR A SUSTAINABLE ENVIRONMENT

Güldiyar Çetin

Department of Industrial Engineering, The Graduate School of Natural and Applied Sciences, Dokuz Eylül University

İzmir, Türkiye

ORCID: 0009-0009-0086-6019

Hasan Selim

Department of Industrial Engineering, Dokuz Eylül University

İzmir, Türkiye

ORCID: 0000-0002-6838-3146

ABSTRACT

Modern global economic growth, which has its origins in the Industrial Revolution, has triggered a significant increase in greenhouse gas (GHG) emissions, primarily carbon dioxide (CO_2), due to the steady rise in energy consumption. Anthropogenic GHGs from uncontrolled industrial activities have disrupted the concentration balance in the atmosphere. As a result, a significant upward trend in global average temperatures has been observed, deepening the climate crisis, one of the most critical issues of the first quarter of the twenty-first century.

The destructive effects of the climate crisis are being measured with scientific evidence, and these results include accelerated melting of glaciers and the associated significant rise in sea levels, an increase in the frequency and intensity of hydrometeorological disasters (such as storms and floods), and widespread ecosystem damage due to changes in forest fire regimes. As a result of this critical situation, environmental sustainability itself is reaching dangerous levels.

The fundamental objective of the Paris Climate Agreement, to which Turkey is a signatory, is to address the systemic environmental imbalance caused by economic growth. This involves an international commitment to keep the global temperature increase below 2°C and strive to limit it to 1.5°C. This international commitment makes decarbonisation a fundamental prerequisite for commercial continuity and competitive market access, particularly for sectors covered by the European Union's (EU) Border Carbon Adjustment Mechanism and organisations exporting to the EU. Considering Turkey's 2053 net-zero emissions journey and its close export ties with the EU, corporate organisations' carbon intensity reduction targets constitute one of the most important building blocks of this process. In this context, accurately measuring and analysing the carbon footprint is critical for the effective management of sustainability efforts.

The effectiveness of efforts to reduce carbon footprints depends not only on valid carbon accounting measurements but also on the accurate diagnosis of complex causal interactions between emission sources. Therefore, effective risk management and impact mapping in line with organisations' sustainability policies have become imperative. In this context, the study aims to provide strategic contributions to organisations' sustainability roadmaps by identifying the root causes and leverage points that most significantly impact greenhouse gas emissions.

This research aims to enable senior management to identify risks early on and determine priority areas for intervention in strategic decision-making processes through a robust risk analysis of carbon footprint improvement. The study also aims to support the achievement of corporate sustainability goals by enabling the anticipation of opportunities and to provide strong competitive manoeuvre recommendations to gain a strategic advantage over competitors.

Keywords: Carbon footprint, corporate sustainability, risk management

SYNTHESIS AND APPLICATION OF CUO NANOPARTICLES FOR TOLUENE CAPTURE IN COMPLEX PETROLEUM WASTEWATER SYSTEMS

Imane Tiffour

Université de Tissemsilt

Algeria

ABSTRACT

Water used in petroleum extraction becomes contaminated with monoaromatic hydrocarbons such as toluene, which poses a significant environmental concern due to their toxicity, persistence in the environment, and low biodegradability. Conventional treatment methods often fail to remove these compounds efficiently, especially under the complex physicochemical conditions found in oilfield-produced water. In this study, we synthesized copper oxide nanoparticles (CuO-NPs) and evaluated their performance as effective adsorbents for toluene removal from synthetic aqueous solutions. The nanoparticles were produced through a controlled chemical precipitation method followed by thermal activation, yielding uniform nanostructures with high surface area and abundant active sites. Comprehensive characterization using X-ray diffraction (XRD), Fourier-transform infrared spectroscopy (FTIR), ultraviolet–visible (UV–Vis) spectroscopy of the CuO-NPs.

Batch adsorption experiments were performed to investigate the effects of critical parameters, including contact time, pH, initial toluene concentration, adsorbent dosage, and temperature. Kinetic analysis revealed rapid adsorption, well described by a pseudo-second-order model, suggesting chemisorption as the dominant mechanism. Equilibrium data fitted the Langmuir isotherm model, indicating monolayer adsorption on energetically homogeneous active sites. Thermodynamic evaluation further demonstrated that the adsorption process is spontaneous and endothermic, consistent with π–electron interactions between toluene molecules and the CuO surface. The nanoparticles also exhibited excellent stability and could be regenerated and reused over multiple adsorption–desorption cycles without significant loss of performance.

Importantly, when applied to water withe Toluene , CuO-NPs maintained high toluene removal efficiency despite, highlighting their robustness in complex environmental matrices. These findings provide valuable insights for the design of nanomaterial-based treatment systems aimed at reducing the environmental impact of hydrocarbon-rich wastewater and contribute to the development of advanced nanomaterial applications in water treatment, while highlighting their potential for industrial implementation.

Keywords: CuO-NPs, Toluene, wastewater, nanoparticules

DETERMINATION OF THE EFFECT OF TEMPERATURE VARIATION ON THE INDEX VALUE IN THE CERCHAR ABRASIVENESS TEST

Şahin Güleryüz

The Graduate School of Natural and Applied Science, Department of Mining Engineering, Dokuz Eylul University

Izmir, Türkiye

ORCID: 0009-0000-3228-3760

Mehmet Volkan Özdoğan

Department of Mining Engineering, Dokuz Eylul University

Izmir, Türkiye

ORCID: 0000-0001-6985-271X

ABSTRACT

In mining, tunneling, and drilling operations, the complex interactions between cutting-drilling bits and rock surfaces, caused by high pressure, friction, and impact effects, lead to significant wear on equipment. This increases operational costs and maintenance frequency, thereby reducing efficiency. The Cerchar Abrasiveness Index (CAI) method, commonly used to predict wear behavior, determines the abrasiveness potential of rocks by measuring the width of the groove (≈ 10 mm) created on the rock by a steel conical tip under a specific load (≈ 70 N). However, all CAI experiments are conducted at room temperature, which does not adequately represent actual field conditions.

During drilling and excavation operations, friction and deformation effects cause significant increases in cutting tip temperatures. This increase directly affects the wear rate by altering both rock behavior and the hardness, ductility, and friction properties of the cutting tip material. It is known that increased temperature reduces the hardness of the cutting edge material and increases its ductility. This situation can change the wear rate in a different direction than expected. On the other hand, high temperatures can weaken the rock due to thermal expansion differences in some minerals, making the rock surface easier to cut, which could theoretically reduce wear on cutting edges. In order to accurately classify these wear amounts, the updated Cerchar Abrasiveness Index (TCAI) will be proposed at the end of the study. With this approach, the aim is to obtain experimental data closer to real working conditions and to make more reliable life predictions for cutting and drilling equipment. At the end of the study, it will be emphasized that cutting tool temperature should not be ignored and that thermal effects occurring in field conditions are a critical parameter in determining wear behavior. Within the scope of this paper, preliminary results of tests conducted on 21 different rock types for this purpose are presented. On the other hand, high temperatures can weaken the rock due to thermal expansion differences in some minerals, making the rock surface easier to cut, which could theoretically reduce wear on cutting edges. To accurately classify these wear amounts, an updated **Thermal Cerchar Abrasiveness Index (TCAI)** will be proposed at the end of the study. With this approach, the goal is to obtain experimental data that more closely approximates real working conditions and to make more reliable life predictions for cutting and drilling equipment.

At the end of the study, it will be emphasized that cutting tool temperature should not be ignored and that thermal effects occurring in field conditions are a critical parameter in determining wear behavior. Within the scope of this paper, preliminary results of tests conducted on 21 different rock types for this purpose are presented.

Keywords: Cerchar abrasion index, equipment wear, drill bit temperature, cutting tool life, excavation efficiency

INSPECTION AND EVALUATION OF RELEVANT REGULATION CHANGE OF BLAST-INDUCED GROUND VIBRATIONS: A CASE STUDY

Mehmet Emre Kılınç

The Graduate School of Natural and Applied Science, Department of Mining Engineering, Dokuz Eylul University

Izmir, Türkiye

ORCID: 0000-0002-8369-9253

Doğan Karakuş

The Graduate School of Natural and Applied Science, Department of Mining Engineering, Dokuz Eylul University

Izmir, Türkiye

ORCID: 0000-0001-6134-1034

Tuğçe Öngen

The Graduate School of Natural and Applied Science, Department of Mining Engineering, Dokuz Eylul University

Izmir, Türkiye

ORCID: 0000-0001-9783-7330

ABSTRACT

Using explosives in mining operations is a-must due to increasing demand of raw materials and average pit depths. Explosive usage and blasting operations create blast-induced vibrations, noise and may cause fly rock because of high-energy release into the ground. Because of blast-induced vibrations and peak particle velocity (PPV), blasting operations are strictly under control with governmental regulations everywhere around the world.

In Turkey, blasting operations are under governmental control with Environment Law No. 2872 (1983) and Environmental Noise Assessment and Management Regulation. Peak particle velocity (PPV) limit values of blast-induced ground vibrations regarding this regulation was updated and/or changed in Nov. 30th 2022, seemingly with no explanation. The reason for regulation change is unknown for both academic and mining industrial sector.

In order to investigate and characterize blast-induced vibrations and determine their impact distances, the importance of the relationship between distance, explosive charge, geological structure and ground tremors, as well as the direction of the blast and the location of the investigated area must be taken into account. During three blastings conducted in the study area, vibration velocity measurement locations were established at different distances in different directions. The distances between the geophone locations and the blasting zones, the instantaneous explosive quantities used in these blasts, and the scaled distances were calculated. Particle velocity and frequency values in three directions obtained from vibration velocity measurements taken from the measurement points (geophones), the explosive quantity, the distance of the measurement point from the blasting zone, the scaled distance, and the resulting particle velocity values were calculated. It is necessary to determine the propagation characteristics of vibrations caused by blasting along the investigated structures. The aim here is to determine the distance and at what distances blasts applied with specific amounts of explosives within the excavation area where blasting is carried out are propagated in the investigated direction. For this purpose, vibration measurements were taken at various explosive amounts and distances in the blasted area and the risky direction, establishing a relationship between scaled distance and resultant particle velocity. To determine the damping distance, the terrain and damping coefficients were modeled using this relationship. Within the scope of this study, Regulation change was inspected and its effect is evaluated with a case study using peak particle velocities (PPV) of ground vibrations of blasting operations.

Keywords: Peak particle velocity, ground vibration, blasting, mining, environmental impact assessment

AN EXPERIMENTAL STUDY ON THE RHEOLOGICAL TEST PROCEDURE OF 3D PRINTABLE CONCRETES

Ebru Kaya

Department of Civil Engineering, Graduate School of Natural and Applied Sciences, Dokuz Eylul University

Izmir, Türkiye

ORCID: 0002-5020-2247

Çağlar Yalçınkaya

Department of Civil Engineering, Faculty of Engineering, Dokuz Eylül University

Izmir, Türkiye

ORCID: 0002-4688-6164

Baraka Ciza

Department of Civil Engineering, Graduate School of Natural and Applied Sciences, Dokuz Eylul University

Izmir, Türkiye

ORCID: 0001-9111-887X

ABSTRACT

The construction industry is experiencing a significant transformation with the adoption of 3D printing technology, which allows the production of complex geometries without the need for traditional formwork. This development has shifted research attention toward the rheological properties of 3D printable concretes, as their flow behavior and buildability are key factors influencing print quality and structural performance. Accurate measurement of rheological parameters, such as yield stress, viscosity, and structural build-up, is therefore essential to ensure proper extrudability and stability of fresh mixtures.

In this study, 3D printable Portland cement-based mixtures containing hydroxypropyl methylcellulose (HPMC) and a superplasticizer were prepared with a water-to-cement ratio of 0.30. Rheological properties were investigated using a vane probe system with two mixing protocols, M1 (single protocol for static yield stress and flow curve measurements) and M2 (separate protocols for these measurements), and two mixing protocol application procedures (P1 and P2) to observe time-dependent behavior at 15 and 30 minutes. In P1, the probe remains immersed throughout the resting period, whereas in P2 it is inserted immediately before testing. Static yield stress, dynamic yield stress, and plastic viscosity were determined, and the effects of probe immersion timing and mixing protocol application procedure on measurement results were assessed. The results show that the static yield stress values at 15 and 30 minutes were identical for both mixing protocols, as static measurements are taken before any shear disturbance and are therefore unaffected by the mixing protocol. The only notable difference occurred between the mixing protocol application procedures (P1 and P2), indicating that probe immersion timing is the main factor governing the accuracy of static yield stress measurements. Therefore, the P1 procedure is considered more reliable because the continuous probe–material contact captures the uninterrupted structural build-up, yielding consistently higher and more representative static yield stress values than P2. The dynamic yield stress and plastic viscosity values increased significantly between 15 and 30 minutes. Both parameters were strongly influenced by the mixing protocol and the mixing protocol application procedure, with the P1 procedure and the M2 protocol providing higher and more sensitive measurements at both ages. It was also observed that the vane probe created a cavity that did not fully close over time, highlighting the importance of testing undisturbed samples.

This research underscores the significance of selecting appropriate measurement protocols for time-dependent rheological analysis in 3D printable concretes and contributes to establishing standardized procedures for characterizing fresh-state behavior, ultimately supporting the development of printable mixtures with improved buildability and structural performance.

Keywords: 3D concrete printing, rheology, yield stress, vane rheometer, viscosity

THE ASSESSMENT OF LONG-TERM AUTOGENOUS SHRINKAGE OF 3D PRINTABLE FIBER-REINFORCED CONCRETES CONTAINING POZZOLANS

Baraka Ciza

Department of Civil Engineering, Graduate School of Natural and Applied Sciences, Dokuz Eylul University

Izmir, Türkiye

ORCID: 0001-9111-887X

Çağlar Yalçınkaya

Department of Civil Engineering, Faculty of Engineering, Dokuz Eylül University

Izmir, Türkiye

ORCID: 0002-4688-6164

Ebru Kaya

Department of Civil Engineering, Graduate School of Natural and Applied Sciences, Dokuz Eylul University

Izmir, Türkiye

ORCID: 0002-5020-2247

ABSTRACT

The usage of supplementary cementitious materials (SCMs) as partial replacements of ordinary Portland cement (OPC) is, to date, the most plausible and conventional way to bring sustainability and environmental friendliness into 3D printable concrete (3DPC) technology, which inherently requires a higher binder volume to achieve the performance requirements of printable mixes. Additionally, the combination of a lower aggregate-to-binder ratio, the absence of coarse aggregate, and the lack of formwork during printing makes 3DPC more susceptible to shrinkage. Furthermore, the incorporation of microfibers as reinforcement is one of the ways to reinforce printed objects while maintaining the architectural freedom of 3DPC. Hence, in this study, the effect of pozzolans as SCMs for CEM I 42.5 R OPC on long-term autogenous shrinkage of fiber-reinforced printable mixtures was investigated. Accordingly, ground granulated blast furnace slag (BFS) and class F fly ash (FA) were used as partial substitutes for OPC at various ratios (0, 20, and 40 %) by weight. Additionally, micro steel fibers with a length of 6 mm were added to the mixes at 0.5% by volume. The long-term autogenous shrinkage strains of the printable mixtures were determined on specimens sealed with aluminum adhesive tape, in accordance with ASTM C-157 standard. The sealed specimens were conserved for 56 days at 20 ºC and 95% RH in a climate chamber. Also, the 7- and 28-day compressive strengths were determined on mold-cast samples after standard water curing. Results show that the long-term shrinkage behavior of the studied mixes varied in accordance with the type of pozzolans, their replacement ratio, and the maturity of the mixture. The addition of BFS resulted in higher overall shrinkage strains of all mixtures, especially on the 56th day. The addition of 20% and 40% BFS increased the shrinkage strains at the 56th day by 13% and 11% respectively. Additionally, the addition of BFS at 20% resulted in higher shrinkage than the 40% addition during the first three days. Unlike BFS, results indicate that the incorporation of FA mitigated the shrinkage behavior of the studied mixes. FA-bearing mixes showed the lowest shrinkage strains of all mixtures at the 56th day. The addition of FA at 40% reduced the overall shrinkage strains by 38% and 56.6% in comparison to the reference and the mixture with 40% BFS addition, respectively. While the effect of BFS on the 7 and 28-day compressive strength was negligible, 20 and 40% FA addition decreased the strength by 20% and 51% at 28 days compared to the reference mix.

Keywords: 3D concrete printing, autogenous shrinkage, pozzolans, micro-steel fiber reinforcement

STATIC BENDING ANALYSIS OF TIMOSHENKO BEAMS ON PASTERNAK ELASTIC FOUNDATION

Filiz Çetinkaya

Kütahya Dumlupınar University,Graduate School of Natural and Applied Sciences, Department of Civil Engineering

Kütahya /Türkiye

ORCID:0009-0004-1145-948X

ABSTRACT

This study presents a comprehensive theoretical framework for the static bending analysis of beams resting on a Pasternak elastic foundation, aiming to improve the accuracy of soil–structure interaction modeling for engineering applications. The formulation integrates Timoshenko beam theory with the Pasternak two-parameter elastic foundation model to overcome the limitations associated with classical assumptions, such as the neglect of shear deformations in non-slender beams and the lack of soil continuity in Winkler models.

In this formulation, the beam is modeled using Timoshenko beam theory, which accounts for transverse shear deformation and is therefore suitable for the analysis of moderately thick or deep beams. Unlike the classical Euler–Bernoulli approach, vertical displacement and cross-sectional rotation are treated as independent kinematic fields, enabling the accurate modeling of shear-related effects. The supporting subgrade is represented by the Pasternak elastic foundation model, which improves upon the Winkler model by incorporating both normal and shear interaction components, ensuring deformation continuity along the beam–soil interface.

The governing equations and associated boundary conditions are derived using the Principle of Minimum Total Potential Energy. The resulting coupled differential equations are solved numerically by means of the Ritz method. As a representative application, a simply supported Timoshenko beam subjected to a uniformly distributed load is analyzed using a single-mode approximation based on trigonometric basis functions.

The numerical results demonstrate that the shear stiffness of the Pasternak foundation significantly influences the static response of the beam, leading to lower and more realistic deflection values compared to those predicted by the classical Winkler foundation model. In addition, the shear correction factor inherent to the Timoshenko theory is shown to have a decisive effect on both maximum deflection and cross-sectional rotations. The findings further confirm that the effective shear force concept provides an appropriate measure for representing the combined contribution of beam and foundation stiffness. Overall, the proposed formulation and solution approach offer a reliable and physically consistent tool for the static analysis and design of non-slender beams resting on elastic foundations.

Keywords: Timoshenko beam theory, Pasternak elastic foundation, Hamilton’s principle, Ritz method

NONLINEAR MOMENT-CURVATURE ANALYSIS OF GLUED LAMINATED TIMBER BEAMS

Hüseyin Kürşat Çelik

Department of Civil Engineering, Izmir University of Economics

Izmir, Türkiye

ORCID: 0000-0001-9408-7116

Gökhan Şakar

Department of Civil Engineering, Dokuz Eylul University

Izmir, Türkiye

ORCID: 0000-0003-0449-248X

ABSTRACT

Timber structures have gained significant popularity in recent years as sustainable and efficient construction materials. Timber offers several advantages, including a high strength-to-weight ratio, ease of shaping desired forms, and suitability for long-span structural applications. These characteristics make timber a favourable material for roofs, bridges, and other beam-type systems where lightweight yet strong members are required. However, despite these benefits, timber also exhibits mechanical drawbacks that must be carefully considered in structural design. One of the most critical aspects is its anisotropic behaviour: the mechanical properties of timber—particularly strength and stiffness—vary substantially with grain direction and loading type. Parallel to the grain, timber can develop limited plastic deformation under compression, whereas in tension it behaves elastically up to a brittle failure. In contrast to this complex behaviour, many commonly used design codes and standards idealise timber as an elastic material and rely on elastic section properties to estimate bending capacity. While convenient for design, such simplifications prevent engineers from capturing the complete nonlinear flexural response of timber members.

To address this limitation, the present study adopts a nonlinear moment–curvature analysis to predict the load-displacement behaviour of glued laminated timber (glulam) beams. The tensile response of timber is modelled as elastic–brittle, while the compressive response is represented using an elastic–perfectly plastic constitutive relationship. Sectional forces are computed by incrementally increasing curvature, and the resulting moment–curvature curves are transformed into load-displacement responses. The analysis is implemented in MATLAB, where sectional equilibrium is solved iteratively using the Newton–Raphson method to ensure convergence at each curvature increment. For modelling simplicity, individual lamination layers are neglected, and the glulam cross-section is treated as a homogeneous material.

An existing experimental study in the literature on the bending performance of glulam beams is used as a reference to validate the proposed analytical approach. The analytical displacement curves generated through nonlinear sectional analysis are compared with the experimental results to assess the model's accuracy in capturing initial stiffness, flexural capacity, displacement characteristics, and overall failure behaviour. The proposed method demonstrates strong agreement with experimental results.

Overall, the findings indicate that nonlinear moment–curvature analysis provides a practical and computationally efficient tool for evaluating the flexural behaviour of glulam beams beyond the elastic range. The approach offers enhanced insight into the structural performance of timber beams, supporting the development of more accurate, performance-based design methodologies for modern timber structures.

Keywords: glued laminated timber beam, moment-curvature analysis, load-displacement curve

FEASIBILITY STUDY OF LOW-COST PHOTONIC SENSORS FOR NON-DESTRUCTIVE SURFACE PROFILE AND ROUGHNESS CHARACTERIZATION

Sonay Onur Avcı

Dokuz Eylül Üniversitesi

İzmir, Türkiye

Metin Sabuncu

Dokuz Eylül Üniversitesi

İzmir, Türkiye

ABSTRACT

Competitive manufacturing requires reducing costs while meeting quality standards. Surface Roughness (SR) is critical for aerospace, medical, and energy sectors. Surface Profile (SP) analysis is essential to evaluate surface geometry, roughness and waviness. Several methods assess SP and SR, like the popular stylus profilometer. Contactless and non-destructive options, which help verify quality without damaging, include interferometry, confocal profilometry, and laser triangulation. While these systems provide detailed surface data and high-resolution SR measurements, their high cost and need for a controlled environment limit accessibility, especially in industrial production.

We evaluate the performance of low-cost optical Time-of-Flight (ToF) sensors for dynamic, non-contact SP extraction and assess their usability in SR detection/measurement. Three distance ranging sensors, VL53L0X, VL53L1X, and TMF8701, were compared. The setup positioned sensors perpendicular to the scanned region while sample surfaces moved at an approximately constant speed. Variation in sensor-sample distance enabled SP extraction. Sample surfaces were prepared from cardboard/paper with diverse colors, with indentation/protrusion thicknesses from 3.5 to 0.1 mm to create artificial roughness profiles. Raw data was processed via a microcontroller. Instantaneous distances provided SP, and statistics were kept. The system's sensitivity to sudden distance changes, beneficial for SR detection, was tested using moving average and median filters in MATLAB.

Results show that VL53L0X and VL53L1X give similar data. VL53L0X could not extract SP below 3 mm, while better performer VL53L1X produced reliable results up to 1.6 mm. Deviations were high in both sensors due to environmental factors and reflectivity. Although all sensors obey ToF principles and use 940 nm infrared lasers, TMF8701's histogram-based processing yielded higher resolution and stability by reducing noise and mitigating material/color effects. TMF8701 extracted SP with 0.75 mm differences; under high contrast (white on black), precision reached 0.1 mm. Although it perceived 0.1 mm as 1 mm, it still extracted profiles. Despite limited accuracy, high precision enabled SP and SR characterization.

In optimal scenarios, the sensor was 5 cm from the surface, and samples moved at approximately 30 mm/s. Further distances and higher speeds reduced precision and detail. Additionally, 1 mm resolution was possible at speeds up to nearly 120 mm/s.

The feasibility of using photonic sensors for SP and SR assessment in industrial applications has been investigated. Advanced Time-of-Flight sensors operate at the millimeter scale and offer potential resolution near 0.1 mm. Although resolution is limited compared to conventional methods, they present a cost-effective, easily applicable, non-destructive alternative for surface characterization.

Keywords: Surface Profile, Surface Roughness, Non-Destructive Measurement, Low-Cost Sensors, Optical ToF Sensors

CONCEPTUAL DESIGN OF GPR MOUNTED UNMANNED GROUND VEHICLE PLATFORM

Ahmet Umut Güngörmüş
Department of Mechanical Engineering, Dokuz Eylul Univesity
İzmir, Türkiye
ORCID: 0009-0001-3047-486X

Tunahan Arslan
Department of Mechanical Engineering, Dokuz Eylul Univesity
İzmir, Türkiye
ORCID: 0009-0003-3810-7874

Seçil Turan Karaoğlan
Department of Geophysics Engineering, Dokuz Eylul Univesity
İzmir, Türkiye
ORCID: 0000-0002-3871-4792

Zülfikar Erhan
Department of Geophysics Engineering, Dokuz Eylul Univesity
İzmir, Türkiye
ORCID: 0000-0001-9572-2337

Mustafa Umut Karaoğlan
Department of Mechanical Engineering, Dokuz Eylul Univesity
İzmir, Türkiye
ORCID: 0000-0002-3780-3451

ABSTRACT

Ground Penetrating Radar (GPR) is a method used to map underground structures, objects, and layers in a non-destructive manner by generating electromagnetic signals. However, using GPR devices manually over rough and large areas makes precise and systematic scanning extremely difficult and places significant physical strain on operators. Preparing the area before scanning and the long hours required for the measurements result in substantial manpower requirements. Our study addresses this gap by offering a durable, scalable, and software-based solution suitable for both academic and industrial applications.

The scientific merit of the project lies in the development of an original system architecture that provides higher performance and modularity compared to existing commercial or academic solutions. In this way, the need for human labor will be reduced, while time-consuming processes such as path planning and operator breaks, which increase overall operation time, will be eliminated. The integration system inside the Unmanned Ground Vehicle (UGV) enables the use of GPR devices of various sizes, and the adjustable positioning of the mounting elements on the chassis allows the height of the vehicle base to be modified. For the UGV's drive system, skid-steering has been adopted, and the vehicle is powered by wheel-embedded HUB motors. This approach enables sharp turns for denser measurement acquisition and provides high traction due to the presence of four independent motors. Ensuring the accuracy of steering, an IMU is used to minimize errors caused by wobbling during maneuvers. Using a microcontroller, the distance traveled is calculated by processing motor speed values and elapsed time parameters. The microcontroller also sends signals to the GPR device at specified intervals, ensuring precise operation, while the measurement data can be processed in real time.

The developed autonomous movement algorithm automatically generates the vehicle’s route in a mapped area and dynamically optimizes the path based on measurement density. When the vehicle reaches the end of a designated measurement line, it stops, calculates its turning movements, and automatically transitions to the next line. This system eliminates common issues in manual measurements such as redundant data, directional deviation, and incorrect positioning. In low battery power, the removable battery system allows instant replacement to ensure uninterrupted measurements.

The primary objective of the project is to reduce human labor in GPR operations that typically require hours of continuous work. Additionally, it aims to minimize potential human-induced errors through the use of our developed vehicle. Therefore, the chassis design, electronic components, and drive system collectively form an integrated structure.

Keywords: Ground Penetrating Radar (GPR), Unmanned Ground Vehicle (UGV), Structural design, Locking sliding mechanism

COMPARATIVE PERFORMANCE ANALYSIS OF FAST ANALOG TO DIGITAL CONVERTER ARCHITECTURES

Gurcu Nur Ayas

Department of Electrical and Electronics Engineering, Dokuz Eylul University

Izmir, Türkiye

ORCID: 0009-0003-9020-7143

Özge Cihanbeğendi

Department of Electrical and Electronics Engineering, Dokuz Eylul University

Izmir, Türkiye

ORCID: 0000-0001-7839-2954

ABSTRACT

Fast analog to digital converters (ADCs), first introduced in the early 1960s, have become one of the fundamental components of many modern applications such as communication systems, sensor interfaces requiring high resolution image and mixed-signal processing. With advances in semiconductor technologies, the need for architectures that offer high bandwidth, consume less power and chip area, provide high sampling rate and accuracy, and remain low in complexity has increased. Therefore, these parameters considered to be key determinants of ADC architectures performance today.

This study presents a comparative analysis of Fast ADC types, namely Flash, Two-step, Pipelined and Folding ADCs. In this analysis, the sampling rate, accuracy, circuit complexity, and power consumption parameters are taken into account.

Flash ADCs, which evaluate the input signal simultaneously using $2^N - 1$ comparators, represent the Flash ADC architecture thanks to their parallel structure, achieving sampling rates above 1 GS/s. Owing to their high sampling rate, Flash ADCs are widely used in radar systems and high-frequency communication applications. However, as the resolution increases, the number of comparators increases exponentially, leading to several limitations, such as increased power consumption and reduced accuracy.

Unlike Flash ADCs, Two-step ADCs divide the conversion process into two stages. In this way, the number of comparators is reduced to $2^M + 2^L - 2$, reducing power consumption and chip area while achieving high accuracy. With sampling rates reaching hundreds of MS/s, Two-step ADCs offer a suitable solution for medium-high-resolution applications.

Pipelined ADC designs can provide both medium-to-high accuracy and medium sampling rates thanks to their sequential processing chain. At each stage, sampling, ADC–DAC conversion, and amplification operations are conducted. Although this structure involves delay, it provides a very efficient solution for wideband digital signal processing applications with a sampling rate in the range of 100–250 MS/s and improved accuracy.

To obtain the speed advantage of Flash ADC, Folding ADC architectures on the other hand contain a pre-processing stage that applies a Folding method to the input signal at predetermined intervals. This method greatly reduces the number of comparators $(2^L-1) + (2^M-1)$, allowing for considerable reductions in chip space and power consumption. Thus, high rates approaching 1 GS/s are conceivable with lower circuit complexity compared to Flash designs.

Consequently, comparisons show that Flash designs offer the fastest speed but are the most costly solution in terms of power and area. While Pipelined ADCs provide a balanced performance in accuracy and sampling rate, Two-step and Folding ADCs offer a more efficient trade-off between sampling rate and power consumption. As a result, each ADC architecture should be selected based on the intended application's speed, accuracy, and power requirements.

Keywords: Flash ADC, Pipelined ADC, Two-step ADC, Folding ADCs

SPATIO-TEMPORAL LAND USE AND LAND COVER TRANSFORMATIONS INDUCED BY THE AKKUYU NUCLEAR POWER PLANT (2005–2025)

Sema Ilgın

Department of City and Regional Planning, Mersin University

Mersin, Türkiye

ORCID: 0009-0002-3772-2536

Alper Yalçın

Department of City and Regional Planning, Mersin University

Mersin, Türkiye

ORCID: 0009-0003-2052-8507

Gülsüm Ecem Demirdağ

Department of City and Regional Planning, Mersin University

Mersin, Türkiye

ORCID: 0000-0001-6876-2114

ABSTRACT

This research investigates the spatio-temporal impacts of the Akkuyu Nuclear Power Plant (NPP) construction on land use and land cover (LULC) transformations between 2005 and 2025. The study aims to identify the extent, direction, and intensity of landscape changes occurring in the surrounding region as a consequence of large-scale energy infrastructure development. As one of Turkey's most significant energy investments, the Akkuyu NPP constitutes a critical case for examining the spatial and environmental implications of industrial expansion on regional land systems. The methodological framework integrates multi-temporal remote sensing analysis with GIS-based spatial modeling techniques. Satellite imagery from different periods was processed using the Google Earth Engine (GEE) platform, allowing efficient handling of large datasets and temporal comparisons. All images underwent pre-processing procedures, including atmospheric correction, cloud and shadow masking, and radiometric normalization. A supervised classification approach was applied to categorize land cover into five main classes: forest, agricultural land, built-up area, open or barren land, and water bodies. Classification outputs were refined and analyzed using ArcMap and QGIS software to ensure spatial accuracy and consistency. The results reveal a clear transformation from predominantly natural land covers to increasingly anthropogenic surfaces over the study period. Forest and agricultural lands experienced notable declines, while built-up areas and open or barren lands expanded significantly. Quantitative change detection analysis indicates that built-up areas increased by 52.9%, water bodies expanded by 2.74%, forest areas decreased by 26.1%, and open or barren lands increased by 135.5%. These findings demonstrate intensified human pressure on the landscape, reflecting the spatial consequences of energy-driven regional development and highlighting the need for environmentally sensitive planning strategies.

Keywords: Akkuyu nuclear power plant, land use and land cover change, remote sensing, google earth engine, GIS

HYBRID REINFORCEMENT LEARNING FOR ENEMY CHASE DECISION-MAKING IN HORROR GAMES

Isra Ben Brahim

Department of Artificial Intelligence, Istanbul Aydın University

İstanbul, Türkiye

ORCID: 0009-0004-9098-9533

Yakup Çelikbilek

Department of Software Engineering, Faculty of Engineering, Istanbul Aydın University

Department of Computer Science, Faculty of Science, Istanbul University

İstanbul, Türkiye

ORCID: 0000-0003-0585-1085

ABSTRACT

This study investigates the use of reinforcement learning for high-level enemy decision-making in a first-person horror game developed using the Unity engine. In many commercial games, enemy behavior is created using handcrafted rule-based logic. These systems typically rely on predefined conditions, such as distance thresholds or line-of-sight checks, to determine when the enemy should switch between behaviors, such as patrolling and chasing. While such approaches are computationally efficient and reliable, they often result in predictable behavior that reduces tension and replayability, particularly in horror game contexts where uncertainty and adaptive responses are essential. To address this limitation, this work introduces a hybrid artificial intelligence architecture in which reinforcement learning is applied exclusively to high-level behavioral decisions. At the same time, low-level movement, navigation, animation, and audio feedback remain under deterministic control. With Unity Machine Learning Agents and Proximal Policy Optimization, the enemy is modeled as an autonomous agent that observes continuous spatial information. The data used is the enemy's own position, the player's position, and the normalized direction vector between them. Based on these observations, the learned policy outputs a binary decision indicating whether the enemy should continue patrolling or initiate a chase. The training process employs episodic resets with randomized spawn locations and a distance-aware reward structure that encourages context-sensitive chasing behavior while penalizing unnecessary or implausible actions. Experimental observations indicate that the trained agent develops more adaptive and less predictable chase decisions when compared to traditional rule-based systems. At the same time, motion, animation, and presentation remain under complete designer control. A key contribution of this study is the observation that applying reinforcement learning only at the decision level yields effective results. This approach improves perceived behavior without requiring changes to existing control or design structures. The results show that hybrid artificial intelligence architectures provide a practical and scalable approach to integrating machine learning into real-time game environments. This is particularly relevant in horror games, where maintaining a degree of unpredictability contributes to player engagement.

Keywords: Reinforcement Learning, Game Artificial Intelligence, Hybrid AI Systems, Unity Machine Learning Agents.

AN INVESTIGATION ON THE HYDROGEN PRODUCTION BY USING GREEN AGNPS AND ITS CATALYTIC EFFICIENCY

Zeynep Ceren Bayındır

Department of Chemistry, The Graduate School of Natural and Applied Sciences,Dokuz Eylül University

İzmir, Türkiye

ORCID: 0009-0004-0067-4328

Levent Çavaş

Department of Chemistry, Faculty of Sciences, Dokuz Eylül University

İzmir, Türkiye

ORCID: 0000-0003-2136-6928

ABSTRACT

Caulerpa lentillifera J. Agardh 1837, a member of *Caulerpa* Genus, is a green macroalga commonly found in tropical and subtropical regions. It is a well-known alga for its high nutritional value and abundance of bioactive compounds. Moreover, it is also rich in phenolic compounds, flavonoids, alkaloids, proteins, and sulfated polysaccharides. This seaweed has remarkable reducing and stabilizing properties, making it a valuable natural source for eco-friendly nanoparticle synthesis. In this study, *C. lentillifera* were used as a natural bioresource for the eco-friendly synthesis of silver nanoparticles (AgNPs), and the catalytic performance of the green-synthesized AgNPs were investigated in the hydrolysis of sodium borohydride ($NaBH_4$) for hydrogen generation. The optimal conditions for AgNPs synthesis for pH, temperature, biomass concentration, silver nitrate concentration, incubation time, and agitation rate were determined to be 11, 25°C, 0.01 g/mL, 8 mM, 3 days, and 0 rpm, respectively. The biosynthesized AgNPs were characterized by using UV-Vis, FT-IR and XRD analyses. For hydrogen generation, the optimal conditions for temperature, agitation rate, pH, $NaBH_4$ concentration were determined to be 50°C, 500 rpm, 3, and 150 mM, respectively. In these conditions, the maximum hydrogen production was measured as 94.2 mL. On the other hand, the self-degredation of $NaBH_4$ was calculated as 36.2 mL at pH 3. The biosynthesized AgNPs has a large surface area, which helps them increase the rate of hydrolysis $NaBH_4$ and hydrogen production. Hydrogen is considered an important clean energy source because it has high energy density, produces no carbon emissions, and only forms water as a byproduct. Therefore, using *C. lentillifera*-based AgNPs are a promising and sustainable option for both nanotechnology and renewable hydrogen production. This approach not only advances green chemistry but also contributes to the development of environmentally friendly energy solutions.The results show that using macroalgae for nanoparticle synthesis is safer, cheaper, and more environmentally friendly than traditional chemical methods. Overall, this study shows that *C. lentillifera* can be used both to produce green nanoparticles and hydrogen. These two abilities connect biotechnology with clean energy and show a new way to integrate marine resources into sustainable technological applications.

Keywords: Caulerpa lentillifera, silver nanoparticles, green catalyst, hydrogen

PREPARATION, CHARACTERIZATION, AND ANTIBACTERIAL EFFICACY OF INCLUSION COMPLEXES CONTAINING BAY ESSENTIAL OIL

Çiğdem Özdemir

Graduate School of Natural and Applied Sciences, Department of Biotechnology, Dokuz Eylül University

Izmir, Türkiye

ORCID: 0009-0001-7299-0133

Ayşe Merih Sarışık

Graduate School of Natural and Applied Sciences, Department of Biotechnology, Dokuz Eylül University

Faculty of Engineering, Department of Textile Engineering, Dokuz Eylul University,

Izmir, Türkiye

ORCID: 0000-0003-0402-2955

ABSTRACT

Cyclodextrins (CDs) are cyclic oligosaccharides obtained from the enzymatic hydrolysis of starch, characterized by a hydrophilic outer surface and a hydrophobic inner cavity. Their unique structure enables inclusion complex formation with hydrophobic guest molecules such as essential oils, enhancing stability, solubility, volatility, and controlled release. Complex formation occurs by insertion into CD cavities, driven by hydrophobic interactions, van der Waals forces, and molecular fit. Methods such as mixing, solvent evaporation, co-precipitation, ultrasonication, or grinding can be used to improve functional properties. The escalating issue of microbial resistance and the demand for long-term product stability necessitate the development of effective, controlled-release antibacterial systems. Encapsulation of natural EOs using carriers like beta-CD represents an innovative approach to preserve antimicrobial efficacy and broaden application areas. Bay leaf (*Laurus nobilis*), endemic to the Mediterranean region, yields an essential oil (LEO) with potent antibacterial and antifungal activity against foodborne pathogens. This efficacy arises from the synergy of components such as terpenes (linalool), oxides (1,8-cineole), and monoterpenes (α-pinene), which disrupt membrane permeability and inhibit enzymes.

The objective of this study was the preparation and efficacy evaluation of LEO-beta-CD inclusion complexes for application in antimicrobial textiles. LEO/beta-CD complexes were prepared at three different ratios (1:1, 1:2, 2:1 Beta-CD:LEO) using the paste complexation method to stabilize LEO's volatile nature and convert it into a more applicable form. Encapsulation yield, DSC, FT-IR, and SEM analyses were conducted to evaluate structural and functional properties. Furthermore, antimicrobial testing was initiated using the disk diffusion technique.

Characterization analyses confirmed successful formation of inclusion complexes at all studied ratios. In terms of encapsulation efficiency, the highest degree of complexation was achieved at 1:1 and 2:1 ratios. SEM images revealed that the inclusion complexes consisted of irregularly sized amorphous particles forming small clusters with a polyhedral geometric structure. No visible cracks or pores were observed on the surface of the inclusion complexes. Furthermore, the prepared complexes exhibited effective antibacterial activity against both Gram-positive and Gram-negative bacterial strains.

In this study, an inclusion complex was prepared using bay leaf essential oil by taking advantage of the molecular-level encapsulation capacity of beta-cyclodextrin. This approach aimed to control the volatile and unstable nature of the essential oil and to transform it into a more stable and applicable form. The increasing problem of microbial resistance and the demand for long-term product stability have highlighted the importance of developing more effective antibacterial systems with controlled release properties. In this context, the encapsulation of natural essential oils using carriers such as cyclodextrins offers a promising and innovative strategy for preserving antimicrobial activity and expanding potential application areas.

Keywords: Laurus nobilis, beta-cyclodextrin, antibacterial

INVESTIGATION OF SOME AMIDE COMPOUNDS BY X-RAY DIFFRACTION AND QUANTUM MECHANICAL METHODS

Emre Karademir

Department of Physics, Graduate School, Hitit University, 19030

Çorum, Türkiye

Arzu Karayel

Department of Physics, Faculty of Engineering and Natural Sciences, Hitit University, 19030

Çorum, Türkiye

ORCID: 0000-0002-3369-8690

Gülsüm Gündoğdu

Department of Energy Science and Technology, Faculty of Science, Turkish-German University, 34820

Beykoz, Istanbul, Türkiye

ORCID: 0000-0003-2380-7942

Gülnihal Erten

Department of Chemistry, Faculty of Science, Pamukkale University

Denizli, Türkiye

ORCID: 0000-0002-5441-2292

Naki Çolak

Department of Chemistry, Faculty of Engineering and Natural Sciences, Hitit University, 19030

Çorum, Türkiye

ORCID: 0000-0001-7181-9556

ABSTRACT

Amide derivatives are compounds that exhibit a wide range of biological activities. In this study, some new amide derivatives were scrutinized both experimentally and theoretically. Six novel compounds—2-chloro-N-(5-mercapto-1,3,4-thiadiazol-2-yl)benzamide (TD-2C), 3-chloro (TD-3C), 4-chloro (TD-4C), as well as 2-chloro-N-(5-methylisoxazol-3-yl)benzamide (I-2C), 3-chloro (I-3C), and 4-chloro (I-4C)—were synthesized and modelled. 1H-NMR, 13C-NMR, FTIR, MS and elemental analyses were carried out. Indexing of the X-ray powder diffraction (XRPD) pattern for TD-3C and TD-4C were determined and refined using conventional laboratory X-ray powder diffraction (PXRD) data. To validate both the assigned space group and the initial lattice parameters, a full-pattern Pawley refinement was conducted. TD-3C and TD-4C compounds crystallized in space group P2 space group and $P\bar{1}$, respectively, with the unit cell parameters a = 32.801(7) Å, b = 4.070(2) Å, c = 17.324(4) Å, β = 83.67(1) °, V = 2299(1) Å³ for TD-3C and a = 6.477(11) Å, b = 19.522(31) Å, c = 22.436(34) Å, α = 99.711(45)°, β = 84.002(46)°, γ = 76.463(43)° and V = 2687(7) Å³ for TD-4C. In addition the most stable states of all structures were determined by using a DFT method (B3LYP/6-31G(D,P) level). The HOMO–LUMO energies, global reactivity parameters, and thermodynamic properties of the compounds were calculated at the same level. The vibrational frequencies of the compounds were obtained, which was determined that all molecules are at a minimum on the potential energy surface, i.e. they do not have an imaginary frequency. The molecular electrostatic potential (MEP) surfaces and HOMO-LUMO diagrams were drawn to better understand and interpret the electronic properties.

Keywords: X-ray diffraction, amide, quantum mechanical calculations, DFT, B3LYP.

THE GREEN SYNTHESIS OF CHITIN AND CHITOSAN AND ITS BIOLOGICAL APPLICATIONS

Büşra Arık

Department of Biology, Graduate School of Natural and Applied Sciences, Erciyes University

Kayseri, Türkiye

ORCID: 0000-0001-6431-0807

Nusret Ayyıldız

Department of Biology, Faculty of Science, Erciyes University

Kayseri, Türkiye

ORCID: 0000-0002-5602-1033

Abdulkadir Taşdemir

Department of Biology, Faculty of Science, Erciyes University

Kayseri, Türkiye

ORCID: 0000-0003-1196-457X

ABSTRACT

Chitin and chitosan can be obtained from natural sources. They are the second most common significant biopolymers in nature after cellulose and have numerous applications, from the food industry to the pharmaceutical industry. Chitin and chitosan are primarily derived from natural sources. Its natural resources are quite wide-ranging, the most important of which are sea shells, insects, spiders, crabs, shrimps and even fungus. Chitosan is a processed form of chitin that has undergone an alkaline acetylation process. Extraction of chitin and chitosan involves a demineralization step, first using solvents such as sulfuric acid, then using NAOH to remove the proteins. Untreated chitin has a highly ordered crystalline structure; it is translucent, flexible, and extremely durable, with low solubility. After undergoing these harsh chemical hydrolysis processes, chitin can form the compound called chitosan.

The process of creating new synthetic substances using plant-derived materials, such as phytochemicals and green solvents, is generally known as green synthesis. However, the production of chitin from all the above-mentioned steps through green synthesis has not yet been fully achieved. The crystal structure, thermal stability, surface morphology, and the presence of functional groups in these compounds are determined using techniques such as FTIR, XRD, TGA, and SEM. Unlike existing heavy chemical pathways, significant advances have been made in the production of chitin and chitosan through green synthesis. In particular, the development of natural deep eutectic solvents and ionic liquids, also known as green solvents, has been a significant step in this area. Under the heading of green fluids, supercritical CO_2 and liquids heated above and below the boiling point are still in the development phase. Microwave-assisted techniques and ultrasound-assisted methods can be examples of advanced processing techniques. Biological methods are among the easiest to achieve in this regard, and bioconversions using biological enzymes and microorganisms are gaining importance. Alternatively, the use of more ecological acids and bases is among the proposed solution methods. Combining all these processes is considered a hybrid method.

Due to their specific physical and chemical properties, chitin and chitosan have a wide range of applications in controlled drug delivery systems, in mucoadhesive drug carriers, in wound healing, in the development of antifungal, antibacterial, and antiviral agents, in gene/cell culture carriers, in enzyme immobilization, in biosensor development, in food packaging, in skin barrier protection, in the cosmetics industry, and in polymer fillers for drugs. Due to their crucial roles in all these biological processes, their production through green synthesis has become a necessity.

Keywords: Chitin, chitosan, green synthesis

BIO-ORGANIC SEMICONDUCTING THIN FILMS: A STRUCTURAL AND ELECTRONIC STUDY

Imane Tiffour

Université de Tissemsilt

Algeria

ABSTRACT

The development of bio-derived organic semiconductors has gained increasing attention in recent years due to their environmental compatibility, low cost, and potential for integration into flexible and sustainable electronic devices. In this work, we report the synthesis, deposition, and comprehensive characterization of thin films based on a molecular complex formed between acetaminophen and curcumin—two naturally abundant, biocompatible molecules known for their rich π-electron systems. The objective of this study is to explore the structural, optical, and electronic properties of this hybrid complex and to assess its relevance as a promising candidate for future organic semiconductor applications.

The acetaminophen–curcumin complex was synthesized through a controlled complexation process in solution, followed by thin-film deposition using a uniform drop-casting technique on pre-cleaned glass and conductive substrates. Structural analysis performed using X-ray diffraction (XRD) revealed the formation of a semi-crystalline material, confirming intermolecular interactions between the two constituents and indicating the presence of ordered domains favorable for charge transport. Fourier-transform infrared spectroscopy (FTIR) demonstrated characteristic shifts in functional group vibrations, providing evidence of hydrogen bonding and electronic coupling within the complex.

Optical properties studied via UV–Vis spectroscopy indicated strong absorption in the visible range, with a noticeable red shift compared to the individual molecules, suggesting enhanced conjugation and a narrowed bandgap. Tauc plot analysis estimated the optical bandgap to fall within the semiconducting range, confirming the material's suitability for optoelectronic integration. Electrical measurements performed using a two-point probe technique revealed stable current–voltage (I–V) characteristics, consistent with semiconducting behavior at room temperature. The electronic response demonstrated reproducibility and sensitivity, highlighting the potential of this bio-organic thin film for low-power electronic devices.

Overall, the findings of this study demonstrate that the acetaminophen–curcumin complex forms a structurally stable, optically active, and electronically functional thin film with promising semiconducting characteristics. The synergy between a naturally derived chromophore (curcumin) and a widely available pharmaceutical compound (acetaminophen) provides a unique pathway toward designing eco-friendly and low-toxicity organic electronic materials. This work contributes valuable insights into the molecular engineering of bio-organic semiconductors and lays foundational groundwork for their integration into sustainable optoelectronic systems, including sensors, flexible electronic platforms, and green photonic devices.

Keywords: Thin film, bio-organic, Semiconductor, Acetaminophene

MACHINE LEARNING-ASSISTED SEPARATION OF CHERENKOV AND SCINTILLATION PHOTONS IN WATER-BASED LIQUID SCINTILLATORS

Tuğçe Ayşegül Çelebi
Graduate School of Natural and Applied Sciences, Erciyes University
Kayseri, Türkiye, 38030
Department of Physics, Sakarya University
Sakarya, Türkiye, 54055
ORCID: 0009-0003-8329-5923

Merve Taş
Artificial Intelligence and Big Data Application and Research Center, Erciyes University
Kayseri, Türkiye, 38030
ORCID: 0000-0003-4877-3347

Dilara Kızılkaya
Department of Computer Science, University of Iowa
Iowa City, Iowa, USA, 52241
ORCID: 0009-0002-6321-7197

M. Anıl Yağız
Department of Engineering and Natural Sciences, Kırıkkale University
Kırıkkale, 71450, Türkiye
ORCID: 0009-0006-3061-7580

Mustafa Kandemir
Department of Physics, Recep Tayyip Erdogan University
Rize, 53100, Türkiye
ORCID: 0000-0002-3642-9699

Emrah Tıraş
Department of Physics, Erciyes University
Kayseri, Türkiye, 38030
Department of Physics and Astronomy, University of Iowa
Iowa City, Iowa, USA, 52241
ORCID: 0000-0002-5628-7464

ABSTRACT

Distinguishing Cherenkov photons from scintillation light in water-based liquid scintillators (WbLS) has recently become a crucial step in improving hybrid neutrino detectors. Since conventional timing-based cuts often fail to isolate the two components with sufficient precision, alternative approaches are needed, especially for detectors where reconstruction performance strongly depends on early photon identification.

In this work, we investigate the application of machine learning methods for photon-level separation using a Geant4 simulation of a WbLS detector. The dataset was generated under both directional and isotropic beam conditions to evaluate the model's performance in diverse optical environments. Several classification algorithms were trained and compared, and gradient-boosting-based models consistently provided better discrimination than standard methods.

After tuning, an ensemble of the best-performing models achieved approximately 96% accuracy for directional events and around 94% for isotropic ones. These results indicate that data-driven photon classification can offer a practical improvement over classical selection strategies and contribute to more reliable event reconstruction in future neutrino experiments employing hybrid Cherenkov/scintillation detection.

Keywords: Water-based liquid scintillator, photon classification, Cherenkov-scintillation separation, machine learning, neutrino detection

EFFECTS OF A MEDITERRANEAN DIET AND EXERCISE PROTOCOL ON GLYCAEMIC PARAMETERS AND BODY COMPOSITION IN PREDIABETES: A PILOT STUDY

Begüm Yücesoy Güneysu

Department of Sports Health Sciences, Marmara University

İstanbul, Türkiye

ORCID: 0000-0001-5092-0516

Özgür Kasımay Berköz

Department of Physiology, Marmara University

İstanbul, Türkiye

ORCID:0000-0002-6294-7174

Elif Tuğçe Akın

Department of Physiology, Marmara University

İstanbul, Türkiye

ORCID: 0009-0003-5746-4631

Hasan Birol Çotuk

Department of Molecular Biotechnology, Turkish-German University

İstanbul, Türkiye

ORCID: 0000-0001-7623-2279

ABSTRACT

Objective: This pilot study aimed to investigate the short-term effects of a phase-based protocol combining a Mediterranean diet with cycling and rowing exercises on glycemic control and body composition in individuals with prediabetes. Continuous glucose monitoring (CGM) was used to evaluate this nonpharmacological lifestyle intervention.

Materials and Methods: This prospective controlled study included 16 sedentary women (aged 22--55) with prediabetes. The intervention group followed a 12-week, four-phase protocol: (1) 2-week diet, (2) 4-week diet + cycling, (3) 4-week diet + rowing, and (4) 2-week diet. The Dexcom G7 CGM system was used throughout. The control group received dietary counselling only. The primary outcomes are the oral glucose tolerance test (OGTT), HbA1c, and fasting insulin. The secondary outcomes include CGM-derived metrics, such as the mean glucose level, glycemic variability (standard deviation [SD], coefficient of variation [CV]), and glucose management indicator (GMI), as well as body weight, body fat percentage, and the waist–hip ratio.

Results: Preliminary data from the first participant to complete the protocol revealed improved glycemic control: HOMA-IR decreased from 4.6 to 2.32, and postprandial glucose decreased from 108 to 53 mg/dL. HbA1c increased marginally from 5.64% to 5.75%. The CGM metrics demonstrated favorable trends; the mean glucose concentration (136, 123, 111, and 114 mg/dL) and GMI (6.6%, 6.3%, 6.0%, and 6.0%, respectively) decreased across phases. Glycemic variability was lowest during the exercise phases (SD: 14, 12, 10, 12 mg/dL; CV: 9.9%, 9.2%, 8.6%, 10.2%). Body composition also improved. Reductions were observed in weight (94 to 81.9 kg), body fat (39.9% to 37.5%), waist circumference (93 to 90 cm), and hip circumference (116 to 112 cm).

Discussion: Preliminary findings suggest that this phase-based protocol combining aerobic and hybrid resistance–aerobic exercise with a Mediterranean diet may improve insulin sensitivity, postprandial glycemia, and glycemic variability in individuals with prediabetes. CGM captured acute, phase-dependent changes more sensitively than HbA1c did. The partial rebound in mean glucose and variability upon exercise cessation in Phase 4 underscores the necessity of sustained exercise. Improvements in body composition likely contributed to the observed glycemic benefits.

Conclusion: The initial data indicate that this CGM-guided, phase-based exercise and Mediterranean diet protocol is a promising strategy for prediabetes management. Rowing exercise appears to be particularly effective in reducing glycemic variability. Upon completion, the study will allow for a clearer delineation of the specific roles of different exercise modalities.

Keywords: Prediabetes, Continuous Glucose Monitoring, Mediterranean Diet, Exercise, Glycemic Variability

THE ROLE OF MAGNESIUM BIGLYCINATE IN EXPERIMENTAL EPILEPSY AND ITS INTERACTION WITH ANTIEPILEPTIC DRUGS

Burcu Sakioğlu

Department of Biology, Graduate School of Natural and Applied Sciences, Erciyes University

Kayseri, Türkiye

ORCID: 0009-0007-2985-9715

Abdulkadir Taşdemir

Department of Biology, Faculty of Science, Erciyes University

Kayseri, Türkiye

ORCID: 0000-0003-1196-457X

ABSTRACT

Epilepsy, which has persisted from ancient times to the present, is a chronic neurological disease in which excessive abnormal discharges originate or spread at a specific point in a group of neurons in the central nervous system. The penicillin-induced epilepsy model is one of the most common acute models and offers rapid results. In this model, cortical areas become the focus of epileptic seizures after penicillin injection. Magnesium is one of the most abundant minerals found in humans and has many physiological functions. Magnesium can suppress seizure activity through its ability to antagonize the N-methyl-D-aspartate (NMDA) receptor. The glycine salt of magnesium is known as magnesium biglycinate. Glycine forms the building blocks of important proteins such as glutathione, porphyrins, purines, heme, and creatine, and exerts both preventive and supportive effects on aspects such as food intake, behavior, and homeostasis. Magnesium glycinate is the organic form of magnesium and is available as a supplement. Levetiracetam (Lev) is a drug used in the treatment of epilepsy and is generally used to control focal, myoclonic, or tonic-clonic seizures. The presented study aimed to investigate the interaction of Magnesium Glycinate (MgB) alone and with the antiepileptic drug levetiracetam after penicillin-induced epileptiform activity in rats.

40 albino male Wistar rats obtained from Erciyes University Experimental and Clinical Research Center were divided into four groups: Control, Penicillin (500 IU, i.c), Penicillin + MgB for 7 days (300 mg/kg, i.p), and Penicillin + MgB + Lev (40 mg/kg, i.p). Epileptic seizures were induced by intracortical penicillin administration, and 30 minutes later, 300 mg/kg MgB was administered. In the interaction group, Lev was administered 10 minutes after the MgB injection. Electrophysiological recordings were recorded using LabChart software. Statistical analyses were performed using SPSS. Throughout the experiment, when the penicillin group and the MgB group were compared, a steady decrease in spike frequency was observed starting from the first minute until the end of the experiment, except for the 70th and 80th minutes. When the MgB-LEV group was compared, a steady decrease in spike frequency was observed starting from the first minute until the end of the experiment. The first statistically significant decrease began at the 10th minute and continued significantly until the end of the experiment.

In conclusion, MgB significantly reduced spike frequency and amplitude both when administered alone and with Lev. MgB and Lev were found to have a synergistic effect on epileptiform activity through different pathways.

Keywords: Epilepsy, experimental model, magnesium biglycinate, levetiracetam

Acknowledgements: This study is supported by Erciyes University Scientific Research Projects Unit with the project number FYL-2023-13244.

AN ALTERNATIVE DATA BALANCING APPROACH TO IMPROVE CLASSIFICATION PERFORMANCE ON IMBALANCED DATA

İhsan Mutlu Karadeniz

The Graduate School of Natural and Applied Sciences Department of Statistics (Data Science Program)

Tınaztepe Campus Buca Izmir 35160 Türkiye

ORCID: 0009-0006-9581-573X

Özlem Ege Oruç

The Graduate School of Natural and Applied Sciences Department of Statistics

Tınaztepe Campus Buca Izmir 35160 Türkiye

ORCID: 0000-0003-0984-5459

ABSTRACT

In critical domains such as medicine, cybersecurity, and finance, misclassifying minority-class instances can lead to severe consequences, making accurate modeling of the minority class essential in imbalanced datasets. DDSC-SMOTE, which generates synthetic samples by considering the data distribution, offers an effective approach in this regard; however, its spectral clustering component incurs high computational cost on large datasets.

In this study, to reduce this cost, the clustering step is replaced with U-SPEC, a method designed for large-scale data processing, thereby enhancing the scalability of DDSC-SMOTE. The proposed approach preserves the data-distribution–oriented processes of DDSC-SMOTE, including noise removal, identifying the cluster structure of the minority class, cluster-based allocation of synthetic sample counts, and relative-position–based selection of initial samples; only the clustering stage is made more efficient through U-SPEC. The representative-based structure of U-SPEC significantly reduces the time and memory requirements compared to classical spectral clustering, especially on large datasets.

Experiments conducted on datasets with varying sizes and imbalance ratios compare classical DDSC-SMOTE with the U-SPEC–based variant, reporting metrics such as G-mean, F1-score, and runtime. The results show that while both methods achieve comparable performance on small datasets, the U-SPEC–based approach provides substantial speed gains on large datasets without compromising classification performance. Overall, this study offers a practical and extensible framework for adapting data-distribution–aware oversampling methods to large-scale imbalanced data problems.

Keywords: Imbalanced Data, Oversampling, DDSC-SMOTE, Spectral Clustering, U-SPEC

SIGN LANGUAGE LETTER RECOGNITION AND PERFORMANCE ANALYSIS USING MACHINE LEARNING METHODS

Ömer Çelikörs

Department of Statistics, Graduate School of Natural and Applied Sciences, Dokuz Eylul University

Izmir, Türkiye

ORCID: 0009-0004-0995-692X

Sedat Çapar

Department of Statistics, Faculty of Science, Dokuz Eylul University

Izmir, Türkiye

ORCID: 0000-0003-4741-4908

ABSTRACT

Recognition of static hand images representing the American Sign Language (ASL) alphabet is an important research area, particularly for developing assistive technologies that can improve communication accessibility for individuals with hearing or speech impairments. This study focuses on the automated classification of 26 static ASL alphabet letters together with the additional signs “delete,” “nothing,” and “space” using modern machine learning and deep learning approaches.

The experiments are conducted on a large publicly available dataset obtained from the Kaggle platform, comprising approximately 223,000 labeled images with a total size of about 4.2 GB. An extensive exploratory data analysis is carried out to examine dataset quality and structure, including the detection of corrupted files, images without visible hands, label distribution imbalance, and variations in image resolution, illumination, contrast, and background complexity. These analyses reveal notable differences across classes, motivating the use of representative and computationally efficient sampling strategies.

To construct reliable training and test sets, a statistically grounded multi-stage sampling framework is employed to ensure balanced and unbiased data selection. Deep feature representations and clustering-based techniques are utilized to capture structural diversity within the dataset while reducing computational cost. Several state-of-the-art convolutional neural network architectures are then trained using the selected samples.

Prior to model training, standard preprocessing and data augmentation techniques, such as normalization and spatial transformations, are applied to enhance generalization performance and reduce the risk of overfitting. Model performance is evaluated using precision, recall, F1-score, confusion matrices, and macro and weighted averages.

The experimental results demonstrate that all evaluated models achieve accuracy levels exceeding 90%, with the best-performing architectures reaching very high accuracy levels of approximately 99% on the test set. These findings indicate that contemporary deep learning models can robustly recognize static ASL alphabet signs despite variations in illumination, background conditions, and hand presentation. The proposed methodological framework provides a reliable basis for efficient sign language recognition systems and contributes to the development of practical assistive technologies for individuals with disabilities.

Keywords: Machine Learning, Image Processing, CNN, Clustering, Sign Language

COLOR-BASED CLASSIFICATION OF FASHION OUTFIT IMAGES USING ARTIFICIAL NEURAL NETWORKS

Nazli Üren

Department of Textile Engineering, Dokuz Eylul University

Izmir, Türkiye

ORCID: 000-0003-4487-7800

A. Fırat Özdemir

Department of Statistics, Dokuz Eylul University

Izmir, Türkiye

ORCID: 0000-0003-4976-7168

ABSTRACT

Fashion research increasingly incorporates artificial intelligence and data-driven approaches. However, the role of color information in predicting fashion styles has remained relatively underexplored. This study investigates whether dominant color features alone can be used to classify stylistic categories and evaluates the effectiveness of different Artificial Neural Network (ANN) architectures in learning color-based style patterns.

The research was conducted in three stages: generation of custom fashion outfit images, computer vision-based color extraction of dominant colors, and supervised machine learning for style prediction. A total of 105 outfit images (35 per style category) were analyzed. The most representative dominant colors were identified via the Mean Shift algorithm and a custom processing pipeline, producing a dataset of 308 labeled colors which was used to train the ANN models.

Multiple ANN architectures were implemented to evaluate the ability of color information derived from the outfit images to predict the style labels. The ANN models differed in several architectural parameters including the choice of activation functions, learning rates, hidden layer configurations, and training epochs. The effect of regularization techniques such as dropout and batch normalization was also investigated. Each model was run 50 times, and the model metrics were calculated.

The results indicated clear performance differences across models. Simpler architectures achieved moderate accuracy levels (0.66 ± 0.02) while the best performance was obtained with a two-layered network (16 and 8 neurons) using tanh or Swish activation functions, reaching an accuracy of 0.77 ± 0.02, precision and recall of 0.78 ± 0.02. Models incorporating batch normalization and dropout regularization exhibited slightly lower performances, suggesting that a moderately deep architecture without heavy regularization captured the style-related color patterns more effectively.

Overall, the findings demonstrated that color information may serve as a meaningful predictor of stylistic identity in fashion images and that ANN models can be used to learn style-related patterns from color-based features. The study additionally shows that even minimal feature sets, when carefully engineered, can yield meaningful predictive signals for computational fashion research. Together, these results suggest that ANN-based fashion style classification may provide valuable insights for various applications, including automated clothing categorization, fashion recommendation systems, digital styling tools, and trend analysis platforms.

Keywords: Color analysis, fashion style classification, artificial neural networks, computational fashion, visual feature extraction

CUSTOMER SEGMENTATION WITH MACHINE LEARNING ALGORITHMS

Zehra Cünt

Data Science, Dokuz Eylül University

Izmir, Türkiye

ORCID: 0009-0004-3605-6185

Tuğba Yıldız

Department of Statistics, Dokuz Eylül University

Izmir, Türkiye

ORCID: 0000-0002-8552-2806

ABSTRACT

In today's highly competitive and rapidly evolving retail environment, understanding customers and accurately identifying their behavioral patterns have become essential for improving marketing effectiveness and strengthening long-term customer relationships. Customer segmentation, which focuses on grouping customers with similar characteristics into meaningful clusters, plays a critical role in developing personalized strategies that enhance customer engagement and optimize resource allocation. This study provides a comprehensive literature review on machine learning–based customer segmentation techniques and evaluates existing studies in terms of their methodological approaches, algorithmic choices, and performance evaluation metrics. The review highlights the increasing use of unsupervised learning methods in extracting actionable insights from large-scale customer datasets.

In the empirical part of the study, a customer segmentation analysis was conducted using real-world sales data obtained from a retail company operating in Turkey. The dataset included transaction-level information; therefore, extensive data preparation steps were required before model development. These steps involved data cleaning to handle missing and inconsistent entries, preprocessing operations such as feature transformations and customer-level aggregation, and feature engineering procedures to derive meaningful behavioral attributes. Additionally, scaling techniques were applied to normalize numerical variables to ensure that clustering algorithms were not biased by differences in feature magnitude.

Behavioral segmentation was performed by integrating traditional RFM (Recency, Frequency, Monetary) metrics with additional features derived from purchasing patterns. Multiple clustering algorithms were implemented to identify the most coherent and interpretable customer groups. The models were evaluated using internal validation metrics, including the Silhouette Score and Davies–Bouldin Index, as well as qualitative assessments of cluster interpretability. Comparative analysis revealed that different algorithms captured customer behavior from distinct perspectives, providing complementary insights for segmentation design.

The preliminary observations suggest that machine learning–based segmentation has the potential to offer meaningful value for retailers by supporting more effective customer targeting, enabling the development of personalized marketing strategies, and informing strategic decision-making processes. The integration of clustering algorithms with domain-specific feature engineering is expected to contribute to the identification of coherent and actionable customer groups. In this context, the research aims to provide a systematic workflow and a conceptual framework that may guide both academic studies and practical implementations regarding the use of machine learning techniques in customer segmentation.

Keywords: Customer segmentation, Clustering, K-means, RFM, HDBSCAN

PREDICTING FINANCIAL CRISES USING MACHINE LEARNING ALGORITHMS

Çetin Vargün

Data Science, Dokuz Eylül University

İzmir, Türkiye

ORCID: 0009-0005-2082-9996

Neslihan Demirel

Statistics, Dokuz Eylül University

İzmir, Türkiye

ORCID: 0000-0002-5394-4721

ABSTRACT

Financial crises continue to constitute some of the most persistent threats to macroeconomic stability, reinforcing the need for empirically grounded early warning frameworks capable of detecting systemic vulnerabilities before they culminate in full scale disruptions. This study proposes a machine-learning-based predictive architecture utilizing the Jordà-Schularick-Taylor Macrohistory Database, which provides an extensive annual macrofinancial panel covering 17 advanced economies over 1870–2020. The dataset encompasses a broad set of indicators related to credit dynamics, debt accumulation, monetary aggregates, investment and consumption behavior, inflation, external balances, and financial market activity. As yield curve information is not available directly, domestic and global term structure measures are constructed ex-post using short and long term interest rate series, enabling the integration of forward looking expectations widely regarded as leading crisis signals in the financial stability literature.

Dimensionality reduction is undertaken through principal component analysis (PCA), which reveals four economically interpretable latent structures. The first component reflects credit expansion and borrowing costs, the second captures public debt and monetary liquidity growth, the third represents the empirically derived domestic and global yield curve configuration, and the fourth embodies inflationary pressures jointly with investment contraction. These components condense high collinearity features into tractable macrofinancial states associated with pre-crisis environments.

The predictive stage employs Long Short-Term Memory (LSTM) neural networks both with and without PCA derived features and benchmarks their performance against Random Forest and XGBoost. Preliminary findings indicate that the incorporation of principal components enhances temporal signal extraction and stabilizes classification dynamics, whereas tree based ensemble models provide informative baselines yet less effective sequencing of crisis transition paths. Model optimisation remains ongoing, including threshold calibration, imbalance handling, and hyperparameter refinement. Interpretability is ensured through Shapley Additive Explanations (SHAP), which consistently identify credit growth, debt-service burden, monetary expansion, and yield curve inversion as primary drivers of crisis probability. The constructed spread indicators successfully replicate forward looking market stress, reinforcing their validity as synthetic early warning measures.

Overall, the study integrates long-horizon macrofinancial history with contemporary machine learning methodology, offering a theoretically anchored and empirically scalable framework for systemic risk surveillance and macroprudential policy design.

Keywords: Machine Learning, Financial Crises, Early Warning System

MACHINE LEARNING ALGORITHMS IN WI-FI NETWORKS

Mustafa Gokcen Ergun

Department of Statistics,Tinaztepe Campus,

Buca, Izmir, Türkiye

ORCID: 0009-0005-0553-0654

Tuğba Yıldız

Department of Statistics,Tinaztepe Campus,

Buca, Izmir, Türkiye

ORCID: 0000-0002-8552-2806

ABSTRACT

Wireless communication systems have become very popular with the development of technology. During this time, Wi-Fi communication has become one of the most commonly used systems because of its efficiency and speed. Although this system brings many advantages, it has also started to become quite complex due to the increasing number of devices, higher traffic and high mobility. As the networks grow, it becomes harder to understand when something goes wrong. Problems such as low Phyrates, wrong roaming decisions and unusual client behavior can reduce user experience. For this reason, detecting anomalies in Wi-Fi networks is an important challenge. This study focuses on building an anomaly detection system using different machine learning methods, including decision trees, random forest, logistic regression, K-Means, LDA+K-Means, isolation forest and UMAP-HDBSCAN algoritms.

The study uses large Wi-Fi log files that include spatial streams of mobile clients and access points, band information,bandwidth, transmit phyrate and a flag that shows whether Wi-Fi traffic exists on the clients. These logs contain millions of records per day. It is hard to examine these logs manually to detect anomalies. To solve this problem, the study compares several machine learning techniques to find which ones work best for identifying anomalies in networks.

The aim of this study is to mark a mobile client as an anomaly when its transmit phyrate value is far below the theoretical limit. In Wi-Fi logs, variables such as spatial streams,band and bandwidth are used as inputs and transmit phyrate value is used as output.Machine learning algorithms are expected to detect anomalies based on the inputs and output values.

Supervised algoritms try to predict the output from the inputs and then compare with the real observed value to get a result. In unsupervised systems, all values are given as inputs and the goal is to observe whether the model can correctly detect anomalies.

In conclusion, this study presents a practical and effective anomaly detection approach for Wi-Fi networks. By using both supervised and unsupervised machine learning models, the system can analyze large volumes of wireless data, detect anomalies and offer useful insights to improve network stability and user experience.

Keywords: machine learning, Wi-Fi communication, anomaly detection

CROSS-ATTENTION TRANSFORMER ARCHITECTURES FOR DRUG–TARGET AFFINITY PREDICTION ON DAVIS AND KIBA BENCHMARKS

Emre Altay

Dokuz Eylul University - The Graduate School of Natural and Applied Sciences

İzmir, Türkiye

ORCID: 0009-0005-9124-4821

İdil Yavuz

Dokuz Eylul University - Faculty of Science, Department of Statistics

İzmir, Türkiye

ORCID: 0000-0003-2163-1066

ABSTRACT

Accurately predicting the binding strength between candidate drug molecules and their protein targets is a central challenge in modern drug discovery, where experimental screening remains slow and expensive. This study investigates how transformer-based architectures can be tailored for drug–target affinity (DTA) prediction using only SMILES strings for small molecules and amino acid sequences for proteins. We propose a cross-attention model in which drugs and proteins are first encoded by separate transformer encoders and then fused via a bidirectional cross-attention layer that explicitly models inter-modal interactions. The model is trained and evaluated on the DAVIS and KIBA kinase benchmarks using mean squared error (MSE), root mean squared error (RMSE), Concordance Index (CI) and area under the precision–recall curve (AUPR) as primary metrics.

To understand which architectural choices most strongly influence performance, we conduct a two-stage ablation study over four key components: positional encoding, normalization scheme, feed-forward network (FFN) type and cross-attention variant. In Stage 1, a 4×4×4×4 grid comprising 256 configurations is explored by training each model for 10 epochs with all other hyperparameters fixed. The results reveal consistent gains for learnable absolute positional embeddings, gated or smooth FFN activations and architectures that include an explicit cross-attention block. In Stage 2, the four best candidates from Stage 1 are retrained for 40 epochs, confirming that a configuration combining absolute positional embeddings, post-norm LayerNorm, GeGLU FFN layers and standard multi-head cross-attention offers the most robust trade-off between error and ranking quality for the dataset considered.

For the selected architecture, we further apply Optuna-based hyperparameter optimization and extended training on both datasets. On DAVIS, the final model trained for 500 epochs reaches a test MSE of 0.2359, RMSE of 0.4858, CI of 0.8786 and AUPR of 0.7243. On KIBA, a 120-epoch run yields a test MSE of 0.1774, RMSE of 0.4213, CI of 0.8782 and AUPR of 0.7966. These results are competitive with recent sequence-only DTA models such as DeepDTA-style CNN and attention-based architectures, while using a conceptually simple, fully sequence-based design.

Overall, this work shows that carefully designed cross-attention transformers can capture rich drug–protein interaction patterns directly from SMILES and protein sequences. The systematic 4×4×4×4 ablation provides practical guidance on positional encoding, normalization, FFN activation and cross-attention design for future DTA models, and suggests that adding structural or multi-modal information on top of the proposed backbone is a promising direction for further improving prediction accuracy.

Keywords: Drug-target affinity, Transformer architecture, deep learning, drug discovery

MACHINE LEARNING ENHANCED CAREER GUIDANCE: DESIGNING AN EXPERIENCE-BASED RECOMMENDATION SYSTEM

Özgür Şeker

Dokuz Eylül University, The Graduate School of Natural and Applied Sciences, Department of Statistics, Data Science Program

İzmir, Türkiye

ORCID: 0009-0001-8542-0359

Engin Yıldıztepe

Dokuz Eylül University, Faculty of Science, Department of Statistics

İzmir, Türkiye

ORCID: 0000-0002-7617-4934

ABSTRACT

One of the primary reasons students drop out of higher education is a mismatch between their chosen major and their interests. Selecting a major is a critical decision that significantly impacts future career satisfaction and long-term job fulfillment. It is one of the most critical stages of the career journey. Without adequate, data-informed guidance, students may experience uncertainty, disengagement, or a loss of motivation, which can result in premature dropout. Beyond the personal consequences for students, such mismatches generate substantial societal costs, including loss of national human capital. Traditional guidance tools, which rely mainly on test scores and rank-based metrics, are insufficient for addressing these challenges because they cannot provide meaningful, personalized program recommendations. In contrast, a recommendation system (RS) driven by real data and behavioral patterns has the potential to provide more nuanced and individualized career guidance solutions.

This study presents a career-guidance service designed with a machine learning–enhanced RS for undergraduate program candidates. This system integrates multi-source psychometric indicators and self-reported academic satisfaction data from current undergraduate students to generate personalized recommendations. Two methods were employed in the study: User-Based Collaborative Filtering (UBCF) and Elastic Net–Regularized Multiclass Logistic Regression (EN-MLR). Both models were trained and evaluated using a cross-validation scheme on a dataset collected from undergraduate students, which prevented data leakage and ensured robust and generalizable performance estimates. The evaluation framework of the study has been expanded to include beyond-accuracy metrics rather than focusing solely on traditional metrics like prediction accuracy. This enables the analysis of the effects of common issues, such as filter bubbles and popularity bias.

The findings reveal a significant trade-off between predictive accuracy and discovery-oriented capabilities among the methods. The model-based EN-MLR method has demonstrated superior performance in terms of normalized reduced cumulative gain, which reflects position-sensitive ranking quality, as well as in precision metrics. On the other hand, the memory-based UBCF approach achieved a higher level of diversity, providing candidates with the opportunity to discover alternative programs they had not previously considered. Additional analyses investigating the contribution of personality traits to model performance indicated that personality-related variables have only a limited direct influence on precision.

In conclusion, the study provides important insights into which approach is better suited for specific career guidance purposes in the design of personalized, next-generation career guidance technologies. In this respect, the study contributes to data-driven solutions that aim to improve candidate student-major matching.

Keywords: recommendation systems, educational data mining, EN–MLR, user-based collaborative filtering

PREDICTIVE MAINTENANCE STUDIES ON CNC MACHINE TOOLS

Merve Karacan Kara

Data Science, Dokuz Eylul University

Izmir, Türkiye

ORCID: 0009-0003-9999-3072

TuğbaYıldız

Department of Statistics, Dokuz Eylul University

Izmir, Türkiye

ORCID: 0000-0002-8552-2806

ABSTRACT

A significant portion of unplanned downtime encountered in modern production systems stems from sudden and unpredictable equipment failures. These failures, which frequently occur in CNC machines, interrupt production flow, reduce operational efficiency, lead to fluctuations in product quality, and substantially increase both spare part consumption and labor costs. Traditional maintenance strategies are predominantly reactive and are triggered only after a failure has occurred. This makes it difficult to continuously and reliably monitor equipment health, while operator-dependent intuitive assessments often fall short of detecting early signs of malfunction. Therefore, developing predictive maintenance approaches capable of identifying potential failures before they occur and enabling timely interventions is of critical importance. This study represents an ongoing and comprehensive research effort aimed at developing a failure prediction system based on the analysis of sensor data obtained from CNC machines using artificial intelligence techniques.

Within the scope of the research, IoT-based sensor data—such as vibration, temperature, spindle speed, and pressure—have been collected in real time and subjected to various preprocessing steps to ensure data quality and consistency. Time series analysis, anomaly detection methods, and machine-learning-based classification algorithms are employed on these data to model and estimate failure probabilities under different operating conditions. Additionally, Remaining Useful Life (RUL) estimation is performed to predict the remaining operational time before a potential failure occurs. Preliminary findings indicate that deviations and anomaly signals observed in sensor behavior are associated with early stages of the failure process, suggesting that the constructed model architecture is suitable for further improvement.

Another component of the system architecture involves the planned calculation of a dynamic health score ranging from 0 to 100 for each machine. This score is intended to present the overall health condition of equipment in an interpretable manner and to support the prioritization of machines approaching critical thresholds. The integration of this feature is expected to significantly enhance the effectiveness of the system as both an operational monitoring tool and a decision-support mechanism.

In conclusion, this study introduces an artificial-intelligence-based approach designed to strengthen predictive maintenance practices in production environments and represents a research effort that is still under development. The ultimate goal of the study is to increase fault prediction accuracy in CNC machines, minimize unplanned downtime, extend equipment lifetime, and contribute to more sustainable and efficient manufacturing processes.

Keywords: Predictive Maintenance, CNC Machines, Machine Learning, Remaining Useful Life (RUL)

FLUID STANDARDS: MEASURING AGING AND SPATIAL ANALYSIS METHODS

Barış Acar

TED University

Ankara, Türkiye

ORCID: 0009-0008-8932-930X

ABSTRACT

Contemporary architecture excels at adapting to external natural forces, creating structures that respond dynamically to wind, sun, and climate; however, it often fails to adjust to the internal natural force of aging. Current architectural measurement systems rely on "idealized" and "static" body models, historically rooted in standards like Le Corbusier's Modulor and Vitruvius's ideal man, which treat the human form as existing in a permanent state. This reliance creates a significant gap between design practices and the "lived realities" of older adults, treating aging as a deviation rather than a biological certainty. This study argues that reliance on static tools results in an "ontological narrowing," where the geometric dimensions of space are prioritized over the anxiety, perception, and fragility experienced by aging users. To address this disconnect, the research introduces two complementary methodological tools that replace fixed norms with a dynamic "morphology of aging".

The first tool, Geraskala, is a theoretical and computational framework that models bodily proportions as flexible and time-dependent. Functioning as a calculator for evolving geometries, it moves away from universal user models to visualize specific biological declines. Utilizing clinical data, Geraskala visualizes the user's capacity not as a fixed circle, but as a shape that deforms into a narrow ellipse or rhomboid over time. The second tool, Groundscape, examines the domestic environment from the bottom up, treating the floor not as a neutral background but as a "terrain of interaction". This method maps "micro-barriers" often ignored in standard plans, such as rug edges, material transitions, and cable hazards. Crucially, Groundscape accounts for perceptual barriers, acknowledging that for an aging eye, a shiny floor may look slippery and induce anxiety, limiting mobility as effectively as a physical wall.

By multiplying these logics, overlaying the contracting geometry of Geraskala onto the environmental resistance of Groundscape, architects can identify exactly where "spatial justice" fails. This approach reveals where a "standard" corridor width transforms into a trap for a shuffling gait, moving the discipline from checking regulatory boxes to analyzing relational dependencies.

Keywords: Architectural Measurement, Morphology of Aging, Spatial Analysis Methods, Ontological Narrowing, Spatial Justice

"LIFE IN-BETWEEN": A CONCEPTUAL INQUIRY INTO COMMON AREAS IN BUILDINGS

Elif Berra Kavuk

Institute of Science and Technology, Balıkesir University

Balıkesir, Türkiye

Fatma Süphan Somalı

Institute of Science and Technology, Balıkesir University

Balıkesir, Türkiye

ORCID: 0000-0003-0242-8345

ABSTRACT

Modernist planning conceptualized the spaces between buildings as voids for air, light and greenery, assuming that "life" takes place at destination points. Distances between these points were treated as stretches to be crossed as quickly as possible, while social interaction was planned as a function confined to recreation areas or within buildings. At the building scale, the same logic prevailed: life was presumed to flourish in rooms, whereas corridors were designed as the shortest channels between functions, spaces for passage rather than occupation.

There were indeed such in-between spaces in various contexts that were deliberately designed. For instance, the sofa, which functioned as an internal shared space into which individual rooms opened, and the hayat, which was a semi-open communal space connected to the exterior in Ottoman–Turkish domestic architecture, were such spaces that fostered social interactions. But with the advent of modernist architectural principles, such spatial elements were gradually replaced by corridors. Corridors fundamentally transformed this spatial logic, emerging as spaces of passage rather than occupation, and were abandoned in social terms. Similar organizational logic has become prevalent in other building typologies.

On the critics of modernist planning, this in-between realm has been extensively rethought at the urban scale. Streets, sidewalks and life between buildings have been revalorized for their capacity to host movement, chance and encounter, and for the productive ambiguity they offer to everyday urban experience. However, this conceptual shift has not travelled to the building scale with the same force. While urban vocabulary includes historically rooted terms such as agora, square; or more recent terms such as public space; architectural literature lacks clear concepts that simultaneously acknowledge movement, transience and the potential for social interaction within building interiors.

It is assumed herein that, where concepts are missing, thinking about space also remains incomplete. This type of conceptualization is fundamental to the discipline of architecture, where spatial understanding is produced through dialectical relationships between form, use, and meaning. Accordingly, this study employs a critical conceptual analysis, and explores currently used concepts (circulation area, gallery, foyer, atriums, etc) around three key criteria including; movement/circulation, temporary occupation potential and chance of encounter. The findings highlight the conceptual gap in the field and the need for a more encompassing conceptual framework.

Keywords: in-between, common area, encounter space

APPLICATION OF LOW-TECH IN ARCHITECTURE AND URBAN LIFE: POTENTIAL USES IN AEGEAN REGION

Onurcan Çakır

Department of Architecture, İzmir Democracy University

İzmir, Türkiye

ORCID: 0000-0002-8191-3658

ABSTRACT

An architecture and lifestyle that avoids high-tech products which are dominating the daily life in cities may be possible in Aegean region. Slowing down life, reducing advanced technologies that we wouldn't need if they weren't imposed on us, reintroducing more primitive but fully functional technologies into our daily lives, regenerating traditional cultures and thus creating new spaces where people can enjoy life; all these can provide a potential solution for Aegean cities which are rich in history and culture. Potentials of climate conditions and natural building materials which are available in this region can lead to a low-tech architecture which is more sustainable, both in terms of energy efficiency and living conditions.

Modern culture has changed our way of living. The sociability of the act of washing clothes by the water, which has been replaced by ultra-technological washing machines, has completely disappeared from daily life. Traffic noise and the amplified background music coming out of the stores have masked any sound of nature and made urbanites forget even the sound of birds. We can never see where the fruits and vegetables we eat actually come from. The right to laziness has completely disappeared in the cities. All of these facts make it completely impossible for us to experience primitive nature, which leads us to an incomplete life experience. As if in a science fiction dystopia, we live in big cities where no one can experience calmness due to heavy traffic, hard working hours, the cacophony of loudspeaker background music we are exposed to, and crowded streets. Skyscrapers are increasing in number every day. Still, a return to the human scale is not impossible even in cities, thanks to low-tech activities and the realization of the natural world in a primitive way, where we can provide ourselves a calm space in the midst of this hustle.

A strong future could be possible by being inspired by the past. Involving design to reconstitute this leisurely and unhurried life is a serious potential that should be examined. Documenting and proposing low-tech related activities and architecture is the main aim of this paper. Examples of low-tech applications in architecture were given and works of Hasan Fathi and Francis Kéré were mentioned. Also, intersections with critical regionalism were discussed by giving examples from works of Aris Konstantinidis. Potentials in Aegean region were presented under the following headings: Use of local materials and natural building materials, opportunities to spend time outdoors, inspiration from vernacular architecture, and utilizing sunlight for passive heating, cooling and ventilation. The integration of these uses in rural areas and towns into cities holds potential for the Aegean region.

Keywords: Low-tech architecture, Aegean region, natural building materials, critical regionalism

THE POTENTIAL OF THE TEXTILE WASTE AS AN ARCHITECTURAL COMPONENT

Şevval Miray Görmüş

Department of Architecture, Faculty of Architecture, Yıldız Technical University

Istanbul, Türkiye

ORCID: 0009-0004-3716-9608

Feride Pınar Arabacıoğlu

Department of Architecture, Faculty of Architecture, Yıldız Technical University

Istanbul, Türkiye

ORCID: 0000-0001-5197-1622

ABSTRACT

The rapidly increasing global volume of textile waste necessitates the search for sustainable materials in architecture. The textile industry's high production volume, short product cycles, and low recycling rates transform this material into a critical environmental challenge. This study examines the usability of textile waste in architecture as a material, surface, shell, dividing element, installation, and urban intervention tool, comprehensively evaluating its potential across physical, performative, sensory, conceptual, and ecological dimensions.

The research examines products and projects incorporating textile waste as architectural elements through a comparative analysis of their transformation types (reuse, recycling, upcycling) and architectural uses (pavilions, membranes, interior surfaces, composite panels, public installations). The findings demonstrate that textile waste offers significant advantages in architectural design. Properties such as lightness, flexibility, portability, permeability, foldability, and interaction with light reveal that the material offers a powerful alternative, particularly in temporary and experimental structures. Furthermore, the performative properties of waste textiles, such as thermal and acoustic insulation, humidity regulation, and atmospheric generation, make significant contributions to interior design practices.

The study also explores the spatial and conceptual qualities of textile waste. The traces, textural differences, and formal distortions carried by used clothing and household textiles add a uniqueness, layering, and memory to architectural spaces not found in standard industrial materials. This transforms textile waste not only into a physical material but also into an element imbued with cultural and emotional meaning in the production of space.

One of the key findings of the research is the extensive use of textile waste, particularly in the pavilion typology. Pavilions, due to their rapid implementation, low cost, and structure amenable to experimental approaches, are considered critical architectural laboratories that highlight the potential of textile waste. Furthermore, interior applications such as composite panels, acoustic surfaces, and rewoven products demonstrate the integration of textile waste into sustainable architectural practices.

In conclusion, the study demonstrates that textile waste holds significant potential in architecture for sustainability, material innovation, and spatial experience. Incorporating textile waste into design processes not only reduces environmental burdens but also creates new formal, structural, and conceptual possibilities. In this context, incorporating textile waste into architectural practice should be seen as a critical step toward low-carbon and circular construction models of the future.

Keywords: Textile waste, architectural textiles, upcycling, circular design, sustainability

DECIPHERING THE CODES OF MIMAR SINAN'S DESIGN EVOLUTION: A COMPARATIVE ANALYSIS OF APPRENTICESHIP, JOURNEYMAN, AND MASTERSHIP WORKS VIA MULTI-MODAL (PLAN AND IMAGE) ARTIFICIAL INTELLIGENCE METHODS

Enes Yalçınoğlu

Department of Architecture, Fırat University

Elazığ, Türkiye

ORCID: 0009-0002-2175-2503

Muhammet Kurucu

Department of Architecture, Fırat University

Elazığ, Türkiye

ORCID: 0000-0001-5088-2863

ABSTRACT

Mimar Sinan, who represents the apex of Classical Ottoman architecture, defined his architectural development as a chronological process of maturation through his works Şehzade (apprenticeship), Süleymaniye (journeyman), and Selimiye (mastery). Architectural history literature has generally examined this evolution in a descriptive manner, focusing on stylistic characteristics, structural engineering competence, or historical context. However, there remains a gap in the literature regarding a quantitative, data-driven analysis—supported by contemporary technologies—of the correlation between the mathematical configuration of Sinan's design language in the two-dimensional plan plane and three-dimensional spatial perception throughout his career. This study aims to analyze this transformation in Sinan's design language through plan schemes and interior space images by employing Multimodal Artificial Intelligence methods, thereby supporting historical observations with numerical data.

The research methodology consists of two fundamental layers, entirely governed by artificial intelligence algorithms and based on the principles of "computational architectural analysis." In the first stage, the plan schemes of the three works were introduced into an AI system and processed using Computer Vision techniques. In this process, the density of structural elements (walls and piers) within the plan plane was scanned using Canny Edge Detection and dilation operations. By analyzing this geometric data, the AI generated a "Structural Density Score" for each building. In the second stage, the same AI system conducted a spaciousness analysis based on interior photographs of the buildings. By analyzing spatial depth and levels of visual openness in the images, the AI calculated "Perceptual Spaciousness" scores. The resulting geometric (plan-based) and visual (image-based) datasets were normalized to a 0–100 scale and subjected to comparative analysis in order to interpret the design evolution.

The findings reveal a striking inverse relationship within Sinan's design strategy. The analyses indicate that, from the apprenticeship period to the mastery period, plan schemes became structurally more complex and advanced. Conversely, AI-based perceptual analyses demonstrate that visual complexity within the interior space decreases, while the sense of "spatial unity" increases. In other words, as Sinan rendered the plan mathematically more demanding, he simplified and enhanced the perceived interior space for the human eye. This study is distinctive in that it reveals the genius of Mimar Sinan not merely through interpretive praise, but through concrete and computable data. Furthermore, it presents a model illustrating how artificial intelligence can be utilized as an analytical evidence-based tool in architectural history research.

Keywords: Mimar Sinan, Artificial Intelligence, Multimodal Analysis, Computer Vision, Architectural Design Evolution

THE USE OF SYMBOLIC DECORATION IN MİMAR SİNAN'S BRIDGES

Zeyneb Çay

Department of Architecture, Fırat University

Elazığ, Türkiye

ORCID: 0009-0001-6424-2960

Muhammet Kurucu

Department of Architecture, Fırat University

Elazığ, Türkiye

ORCID: 0000-0001-5088-2863

ABSTRACT

The works of Mimar Sinan are among the examples that most powerfully reflect the balance between aesthetics and engineering in the Ottoman classical period.Sinan played a defining role not only in religious and public structures but also in the development of transportation infrastructure;he designed bridges as strategic structures that ensured the political,military and commercial integration of the imperial geography.The bridges Sinan built during this period were designed not merely as structures providing physical connection but as monumental works that presented a visual display of the empire's power in structures and left permanent marks in social memory.Research on Sinan has mostly been conducted through mosques,complexes and religious buildings;decorations,dome transition systems,plan schemes and material usage in these structures have been examined in detail.Mimar Sinan's bridges have mostly been addressed for their engineering achievements,arch statics and technical solutions developed against floods;the symbolic and aesthetic dimensions of these structures have been examined to a limited extent in the literature. However,Sinan's works are not only engineering products that provide transportation but also artworks that reflect the aesthetic ideals of the period and the concept of "beauty" at the structural scale.

Within the scope of the study,monumental Mimar Sinan bridges built in the same period were examined:Büyükçekmece Bridge, Lüleburgaz Bridge, Silivri Bridge and Visegrad/Drina bridges.In these bridges,decoration appears not as intense relief on stone surfaces and floral ornamentation but rather with a design language produced through proportional order,rhythm,light-shadow plays,placement of inscriptions and symbols and the visual harmony created by the arrangement of arches.In this context,the decoration approach seen in Sinan's bridges can be evaluated as a symbolic communication model established between the load-bearing system and visual narrative,rather than a formal ornamentation.The light-shadow contrasts formed on bridge arches,reflections on the water surface,stone texture and surface workmanship give the structure a dynamic visual depth.Thus, bridges transcend being merely infrastructure elements providing passage;they transform into architectural focal points that shape geographical,social and political memory and enrich spatial experience.This study aims to reread the phenomenon of decoration in Sinan's bridge architecture and propose recommendations for the preservation of these decorations;it proposes a new evaluation framework that considers bridges in aesthetic,symbolic and spatial integrity.Qualitative,comparative and descriptive analysis methods were adopted in the research.As a result of the research,we see that the decoration phenomenon in Sinan's bridges serves not only visual pleasure but also the principles of function,symbolism and spatial continuity;the architectural form itself is used as a narrative tool.

Keywords: Mimar Sinan, Bridge architecture, Ornamentation, Symbolism

TWO PINNACLES OF THE CENTRAL PLAN: A COMPARATIVE ANALYSIS OF THE SPATIAL ORGANIZATION AND STRUCTURAL FRAMEWORK OF THE SÜLEYMANIYE MOSQUE AND ST. PETER'S BASILICA

Merve Ayaz

Department of Architecture, Firat University,

Elazıg, Türkiye

ORCID: 0009-0003-6815-0697

Muhammet Kurucu

Department of Architecture, Firat University,

Elazıg, Türkiye

ORCID: 0000-0001-5088-2863

ABSTRACT

This study aims to undertake a comparative examination of Süleymaniye Mosque—one of the most distinguished monuments of the Ottoman Classical period—and St. Peter's Basilica, a seminal architectural work of the Renaissance and Baroque eras, focusing specifically on their spatial organization and structural configuration. Although both structures were conceived to emphasize the sanctity, centrality, and monumentality of sacred space, they exhibit distinct spatial strategies shaped by the cultural, religious, and technological contexts of their respective traditions. The central research problem is to analyze how these two monumental buildings converge and diverge in their approaches to forming a dominant central space, particularly through structural innovation, hierarchical spatial layering, and the articulation of circulation patterns.

In Süleymaniye Mosque, Mimar Sinan achieves a balanced and harmoniously integrated spatial composition. The central dome is supported by semi-domes, buttresses, and a systematic arrangement of subsidiary spaces, creating both horizontal continuity and vertical stability. The mosque interior is characterized by a refined geometric order, rhythmic structural intervals, and a carefully calibrated use of natural light, all of which contribute to a unified spatial perception. By contrast, the spatial development of St. Peter's Basilica begins with Bramante's ideal centralized plan, later reshaped by Michelangelo's monumental dome emphasizing verticality and mass. Carlo Maderno's addition of an extended nave transforms the basilica into a hybrid system that combines axial progression with central-core emphasis, blending Renaissance ideals of geometric perfection with Baroque tendencies toward spatial drama and theatricality.

From a structural perspective, Süleymaniye reflects Sinan's mastery in creating rational, earthquake-resistant systems, employing a sophisticated distribution of loads and buttressing elements. St. Peter's Basilica, on the other hand, demonstrates technical audacity through its massive piers, ribbed dome structure, and wide-spanning architectural components, showcasing the engineering ambitions of Renaissance and Baroque Rome.

Overall, this comparative analysis reveals that the conceptualization of sacred space in different civilizations can be meaningfully interpreted through their central-space design strategies. Moreover, it highlights the critical role of structural solutions in shaping the experiential and symbolic dimensions of sacred architecture. By situating both monuments within their historical and technological contexts, the study offers a renewed assessment of their lasting significance in architectural history.

Keywords: Suleymaniye Mosque, St. Peter's Basilica, Mimar Sinan, Central Plan, Spatial Organization.

AN EVALUATION OF THE HISTORICAL DEVELOPMENT OF COURTYARDS IN MOSQUE BUILDINGS DURING THE PERIOD OF ARCHITECT SINAN

Serap Akkuş

Department of Architecture, Firat University

Elazığ, Türkiye

ORCID: 0009-0009-3905-1634

Muhammet Kurucu

Department of Architecture, Firat University

Elazığ,Türkiye

ORCID: 0000-0001-5088-2863

ABSTRACT

Chief Architect Koca Mimar Sinan, who left an extraordinary architectural legacy in the 16th century, is widely recognized for his monumental mosque designs, which played a crucial role in shaping Ottoman urban and social life. Mosques were not merely religious structures but also significant civic spaces where administrators and community members interacted. Among their architectural components, courtyards served as transitional and sociocultural zones where individuals gathered, conversed, or prepared for worship. This study examines the evolution of courtyard structures in Sinan's mosques, tracing their architectural development from his early works to his master period.

The analysis evaluates various architectural features, including courtyard plan typologies, entrance gates, monumental portals (taç kapı), the arrangement of porticoes (revak), fountains (şadırvan), and the spatial relationship between the courtyard and the main mosque structure. In early works such as the Şehzade and Bayezid Mosques, Sinan employed a balanced, restrained, and sharply geometric courtyard modulation. During his journeyman period, the expansive scale of the Süleymaniye Mosque required a rectangular courtyard plan. The placement of minarets on all four sides of the courtyard further emphasized the symmetrical unity of the complex. When viewed from the Golden Horn, the dome merges with the mosque's silhouette, creating a visually integrated monumental effect. The three-tiered monumental portal constructed from white marble and red porphyry stone enhances the dramatic quality of the entrance sequence.

In Sinan's masterpiece, the Selimiye Mosque, the spacious courtyard is cohesively integrated with the last congregation area. The octagonal baldachin structure is completed by proportionally arranged porticoes, arch openings, and narrower side intervals that emphasize the central entrance. This distinctive configuration represents an innovative portico arrangement compared with earlier examples. While porticoes were often independent architectural elements, in Selimiye they reinforce the courtyard's compositional unity, resulting in a more compact and monumental spatial organization. Fountains in the courtyards of Selimiye and Süleymaniye were designed with greater ornamentation, featuring bronze grilles and vegetal motifs. Sinan's courtyards not only supported religious functions but also facilitated social interaction, provided shaded areas suited to climatic needs, and served as hubs of daily communal life. Overall, Sinan's courtyard designs reflect balanced architectural compositions shaped by function, climate, and social dynamics.

Keywords: Mimar Sinan, Mosque Courtyard, Ottoman Architecture, Courtyard Design, Şadırvan

AN ASSESSMENT ABOUT THE SOCIO-CULTURAL DIMENSION OF SMART CITY STRATEGIES

Muharrem Duran

Institute of Natural and Applied Sciences, Trakya University

Edirne, Türkiye

ORCID: 0009-0006-9777-5065

Damla Atik

Faculty of Architecture, Trakya University)

Edirne, Türkiye

ORCID: 0000-0003-3963-3844

ABSTRACT

The rapid growth of cities driven by increasing population pressures and shifting global dynamics continues to accelerate discussions concerning contemporary urban challenges and the future of cities in today's world. New approaches and tendencies have emerged within current models of urban transformation, and ongoing needs and problems in cities are addressed not only through traditional urban planning strategies but also within the framework of "smart city" applications. These applications predominantly focus on technology-oriented solutions directed at the physical environment, often evaluated through utopian or dystopian scenarios, while certain social dynamics remain insufficiently acknowledged. Moreover, the increasing alignment of smart city discourse with objectives such as economic competitiveness, digital optimization, and global market positioning raises additional concerns about the gradual erosion of collective social values and civic sensitivities.

As confidence grows in the ability of advanced technological systems to resolve "urban" problems, the body of literature addressing data-driven decision-making, automation, and infrastructural intelligence has expanded significantly. However, this technocentric perspective has simultaneously exposed a notable gap in studies that explores the sociological, psychological, and cultural implications of smart city transformations. The ambition to automate complex urban functions through artificial intelligence–supported mechanisms risks diminishing human agency, altering patterns of daily life, and reshaping social relationships in unintended ways. Furthermore, the capacity of technology to influence symbolic, cultural, and experiential dimensions of urban life underscores the need to critically examine issues such as identity, belonging, cultural continuity, inclusivity, and the emotional bonds individuals establish with urban spaces.

Within this context, the present study evaluates smart city strategies through a socio-cultural and critical lens; identifying potential challenges associated with the human and societal dimensions based on an extensive review of literature. Highlighting these issues allows for a more comprehensive and human-centered evaluation of smart city and technology integration as an urban planning strategy. Ultimately, the study argues that sustainable and equitable urban development requires maintaining human-centered priorities throughout technological transitions. Emphasizing social well-being, cultural resilience, and meaningful public engagement is essential to ensuring that emerging smart city models contribute not only to efficiency and innovation but also to the preservation of the symbolic, cultural, and relational foundations that shape urban identity.

Keywords: Smart city, human, technology, society, artificial intelligence

SUSTAINABLE URBAN TRANSFORMATION MODELS

Habsa Abdi Farah

Faculty of Technology, Department of Civil Engineering, Firat University

Elazığ, Central, Türkiye

ORCID: 0009-0000-6301-3966

Cevdet Emin Ekinci

Faculty of Technology, Department of Civil Engineering, Firat University

Elazığ, Central, Türkiye

ORCID: 0000-0002-7114-4832

ABSTRACT

This study examines sustainable urban transformation models. Urban transformation is a comprehensive project design process that takes into account economic, spatial, and social conditions to improve unhealthy urban fabrics and solve urban problems. Sustainable urban transformation models are approaches to restructuring cities by prioritizing environmental, economic, and social sustainability. These models aim to improve the future quality of life of cities while taking into account the efficient use of natural resources, energy saving, social justice, and economic development.

Urban transformation models preferred in developed countries are generally based on sustainable approaches, promote social cohesion, and are economically efficient. Urban transformation projects in these countries focus more on the reconstruction and improvement of existing areas. In developed countries, models such as Carbon Emission Reduction (Green Urban Transformation), Social and Social Cohesion (Participatory Urban Transformation), Smart Cities, Interior Renewal and Preservation of Historic Buildings, Light Transportation and Infrastructure Improvements are applied. Urban transformation in undeveloped or underdeveloped countries is often based on different dynamics, social and economic challenges.

Urban transformation projects in these countries often focus on addressing existing infrastructure deficiencies, managing rapid population growth and solving the growing problems of cities. In these countries, there may be models such as Slum Transformation and Housing Renewal, Transformation of Poorly Developed Areas, Infrastructure Improvements and Basic Services, Economic Development and Commercial Development, Urban Sprawl and New Housing Areas, Disaster Resistant Housing and Infrastructure, Urban Agriculture and Green Space Development.Regardless of which model is preferred, some problems are encountered in sustainable urban transformation projects.

These problems include problems in the planning and design phase, inadequate material and resource problems, protection of old buildings and demolition process, legal and bureaucratic obstacles, social and economic problems, etc. To avoid such problems, it is important to choose the appropriate model. In this study, the issues and rational solution suggestions about urban transformation models in developed, underdeveloped, or undeveloped countries will be shared.

Keywords: Urban Transformation, Smart Cities, Carbon Footprint Reduction, Natural Disaster Resistant Structures, Transportation and Infrastructure Innovations.

BIBLIOMETRIC EVALUATION OF THE SMART CITY APPROACH IN THE CONTEXT OF LANDSCAPE ARCHITECTURE

Bünyamin Aydınhan

Institute of Natural and Applied Sciences, Trakya University

Edirne, Türkiye

ORCID: 0009-0002-5786-2317

Damla Atik

Faculty of Architecture, Trakya University

Edirne, Türkiye

ORCID: 0000-0003-3963-3844

ABSTRACT

In planning and design studies related to urban environments, landscape architecture -positioned at the intermediate and outdoor spatial scale- intersects with urban planning and regional planning, which operate at the macro scale, and architecture, which functions at the micro scale. These disciplines share a common foundation, grounded in organizing space based on human needs, approaching the natural and built environment through a holistic lens, prioritizing sustainability, accessibility, and aesthetic values, and ultimately aiming to enhance urban quality of life. The relationship among these fields is built upon mutual interaction and complementarity.

In contemporary literature, the concept of the "smart city" falls within the scope of all three disciplines and is emphasized particularly in areas such as urban design and urban transformation. Understanding how design criteria—evaluated through spatial and data analysis as well as sociological and cultural parameters—are interpreted and shaped within the framework of the smart city approach constitutes the main objective of this study.

Within this context, in order to evaluate the subject specifically from the perspective of landscape architecture, postgraduate theses produced in the relevant programs of these three disciplines were analyzed bibliometrically using data obtained from the National Thesis Center of the Council of Higher Education of Türkiye. Through this analysis, research trends, knowledge production dynamics, relationships among researchers, and the development of scientific fields related to smart cities in Türkiye—as well as the structure and patterns of the literature—were revealed based on objective criteria.

It was determined that the first thesis on the topic of smart cities was completed in 2000 within the field of urban and regional planning. An examination of publication counts (production trends by year) and thematic development revealed that, as of 2000, a total of 266 theses across 37 distinct fields had been recorded. Of these studies, 16.54% belonged to urban and regional planning, 8.27% to architecture, and 2.63% to landscape architecture, with the combined share of the three disciplines calculated as 27.44%. These ratios reflect the distribution of postgraduate theses across the respective fields.

Despite limitations arising from dependence on a specific data source and reliance on quantitative data, the bibliometric analysis facilitated the tracking of thematic evolution, provided an objective view of how the smart city concept has been utilized, and assisted in identifying gaps within the literature. The study highlights the quantitative development of smart city research over the years and reveals that thesis studies within the field of landscape architecture began in 2021, indicating a notable gap in this area. Accordingly, the research aims to guide academics and students in shaping future studies.

Keywords: Smart city literature, bibliometric analysis, urban design, landscape architecture, database analysis

SPATIAL PLAN EVALUATION IN TERMS OF CLIMATE CHANGE: INSIGHTS FROM TÜRKIYE AND OTHER COUNTRIES

Asya Kocabıyık

Department of City and Regional Planning, Graduate School of Natural and Applied Sciences, Dokuz Eylül University

İzmir, Türkiye

ORCID: 0009-0001-4171-9711

İlgi Atay Kaya

Department of City and Regional Planning, Faculty of Architecture, Dokuz Eylül University

İzmir, Türkiye

ORCID:0000-0002-1764-1408

**This study is based on the master's thesis in progress, titled "An Examination of Environmental Zoning Plans in the Context of Climate Change Policies", prepared by Asya Kocabıyık in the Department of City and Regional Planning, Graduate School of Natural and Applied Sciences at Dokuz Eylül University under the supervision of Assoc. Prof. Dr. İlgi Atay Kaya.*

ABSTRACT

The increasing impacts of climate change on cities underscore the necessity of integrating climate change policies into spatial planning processes. Spatial plans, which guide land-use decisions, ensure the efficient use of resources, and direct sustainable urban development, play a crucial role in addressing climate change and its effects. However, examinations of spatial planning processes and implementation practices across various countries reveal a significant integration challenge. Although many countries incorporate strong strategies to address the impacts of climate change within their planning goals, various challenges hinder their effective implementation. Evidence from the literature on plan evaluation demonstrates that countries vary considerably in the extent to climate change integration. In the Netherlands, adaptation to climate impacts are addressed through project-based and fragmented initiatives rather than through inclusive and holistic planning approaches. In the United Kingdom, limited institutional capacity within local authorities constrains the effective incorporation of climate-related goals into statutory planning mechanisms. Studies on Germany and Spain highlight that insufficient coordination across administrative levels undermines policy coherence between sectoral objectives and climate policies. In the United States, analyses of climate action plans show that most strategies are oriented toward municipal operations, and nearly half focus on developing new plans and assessments. The dominance of the energy and transportation sectors reveals shortcomings in cross-sectoral cooperation, the development of strong interventions, and the integration of climate actions across the broader urban domain, particularly in areas such as food and water. Similarly in Turkey, although climate change mitigation and adaptation strategies are articulated in guiding documents such as the National Climate Change Strategy and the Climate Change Action Plan, these strategies are only partially reflected in spatial plans. Weak monitoring and legal mechanisms, limited inter-institutional coordination, and the low prioritization of climate considerations among other sectoral decisions hinder the incorporation of climate-oriented planning goals into plan-making processes. This study evaluates the integration issues between spatial planning and climate change policies in Turkey and various countries through a comparative literature analysis, identifying common challenges, institutional limitations, and structural constraints. The findings emphasize the importance of enhancing inter-institutional cooperation, integrating climate-compatible planning strategies across the planning hierarchy, and expanding the use of spatial data tools to detect land-use changes, each of which is essential for achieving coherence with climate change policies.

Keywords: Plan Evaluation, Spatial Planning, Climate Change, Policy Integration

CHRONO-TOD: THE 15-MINUTE CITY AS THE MISSING DIMENSION IN TRANSIT-ORIENTED DEVELOPMENT (TOD)

Brian Bichanga Oburu

Department of City and Regional Planning, Graduate School of Natural and Applied Sciences, Dokuz Eylül University

Izmir, Türkiye

ORCID: 0009-0000-4800-4877

İlgi Atay Kaya

Department of City and Regional Planning, Faculty of Architecture, Dokuz Eylül University

Izmir, Türkiye

ORCID: 0000-0002-1764-1408

ABSTRACT

Recent challenges of urban planning are the automobile dependence and socio-spatial segregation. One prominent framework to cope with them is the Transit-Oriented Development (TOD), which promotes the integration of land use and transport planning to enhance accessibility and reduce reliance on vehicles. However, TOD has often prioritized regional connectivity (Node) over local accessibility (Place), frequently resulting in Transit Adjacent Development (TAD). TAD represents station areas that are highly connected but lack functional completeness, ultimately failing to achieve the intended benefits of their locations. Conversely, the 15-Minute City (15mC) inverts this focus, prioritizing local proximity and walkability. However, while the 15mC focuses on the local place, it frequently underestimates the necessity of regional connectivity and integration.

This research identifies a gap in these concepts where TOD prioritizes the region but neglects the local sphere, while the 15mC prioritizes the local sphere but neglects the region. To bridge this gap, this study proposes the "Chrono-TOD" framework, a theoretical synthesis that re-operationalizes the 'Place' dimension of the established Node-Place (NP) model. By performing a comparative analysis of TOD and 15mC and utilizing the NP model as a diagnostic lens, the research deconstructs the limitations of current planning metrics to advocate for a holistic integration that balances local accessibility with regional connectivity.

The proposed framework shifts the unit of analysis from Euclidean buffers to network-based isochrones. It replaces generic land-use entropy indices with functional completeness based on the temporal availability of six essential urban social functions (living, working, commerce, healthcare, education, entertainment). This research provides a rigorous methodological blueprint for establishing 15-minute stations that are sensitive to the temporal dynamics of urban life. Ultimately, this research contributes to urban research and practice by moving the planning focus from mobility-oriented to proximity-oriented planning.

Keywords: Transit-Oriented Development (TOD), 15-Minute City, Node-Place Model, Chrono-Urbanism, Transit-Adjacent Development (TAD)

[*] This paper is based on the ongoing Master's thesis prepared Brian Bichanga Oburu and supervised by Assoc. Prof. Dr. İlgi Atay Kaya at the Department of City and Regional Planning, Graduate School of Natural and Applied Sciences, Dokuz Eylul University, Izmir, Türkiye.

ERROR OR DISCOVERY? THE SPATIAL VALUE OF 'FALSE POSITIVE' COMMERCIAL ZONES DETECTED BY MACHINE LEARNING: THE CASE OF IZMIR

Delfin Gümnay Ercan

City and Regional Planning PhD Program, Graduate School of Natural and Applied Sciences, Dokuz Eylül University

Izmir, Türkiye

ORCID: 0000-0002-6237-5567

Kemal Mert Çubukçu

Department of City and Regional Planning, Dokuz Eylül University

Izmir, Türkiye

ORCID: 0000-0003-3604-7014

ABSTRACT

Traditional urban planning disciplines have long depended on static, definitive indicators such as employment densities, designated industrial clusters, and official zoning boundaries to delineate urban centers. This conventional framework operates on the assumption of a predictable, structured urban growth. However, contemporary 21st-century cities—often characterized as "postmodern"—exhibit a far more intricate and decentralized structure. Conceptualized through the lens of "Keno Capitalism," these modern urban environments develop via a logic of capital flow and network-based clustering that may appear random or mosaic-like to the traditional eye. In this fluid urban order, functional centers emerge spontaneously at points where high human mobility, digital connectivity, and urban amenities intersect, often operating entirely independently of formal planning decisions.

This study, focused on the case of Izmir, utilizes open data sources and spatial statistical methods to argue that the perceived "errors" or "False Positives" generated by machine learning algorithms are, in fact, vital spatial clues for identifying these emerging fluid centers. The methodological backbone of the research involves a Spatial Binary Logistic Regression model. The independent variables used to predict commercial activity include Night-Time Lights (NTL) to measure economic intensity, Bus Stop Heatmaps for public transit accessibility, Network Density for connectivity, and Road Accessibility indices. The dependent variable was derived from Google Maps API to identify actual service and commercial areas.

A significant challenge encountered during the modeling process was the "Class Imbalance" inherent in urban spatial data. Since commercial zones represent a minority class compared to the vast non-commercial landscape, the initial model fell into the "Accuracy Paradox". While it yielded a misleadingly high Accuracy rate of 95%, its Recall—the ability to correctly identify actual commercial centers—was a mere 2% to 3%. To rectify this, a "Balanced Design" approach using undersampling was implemented to create a training set with an equal distribution of commercial and non-commercial points. Additionally, the Youden Index (J) was utilized to optimize the probability threshold, shifting the cut-off to 0.04 to maximize the model's discriminative power.

Following these methodological refinements, the model's Recall rate surged to 90.57%. However, the most profound contribution of this study lies not in the model's success, but in its "deviations". The analysis identified approximately 3,972 "False Positive" points across the entire dataset. These are areas that the official zoning plans do not recognize as commercial, yet the model—having learned the spatial signatures of commerce—confidently classified them as such. Spatial analysis of these "errors" revealed they were not random noise but clustered clusters adjacent to existing urban footprints or along major road networks. These zones exhibit high NTL brightness and superior connectivity, fitting the definition of "High Amenity Zones" (HAZ). Ultimately, this research suggests that "false positives" in machine learning could be recontextualized as a spatial "Early Warning System," potentially providing planners with digital traces of where the city is naturally evolving beyond the static map. By shifting the perspective from "error" to "discovery," these algorithmic outputs can be viewed as indicators of emerging urban dynamics that traditional planning tools may overlook.

Keywords: false positives, potential centers, machine learning, open data, keno capitalism.

UNDERSTANDING THE MULTI-LAYERED CHARACTER OF AN ARCHAEOLOGICAL SITE: THE ANCIENT CITY OF STRATONIKEIA

Zeynep Simay Gümüşlü

Architect, Dokuz Eylül Universty, Graduate School of Natural and Applied Sciences, Department of Architecture, Restoration Program

İzmir, Buca, Türkiye

ORCID: 0009-0004-9096-9532

Mine Tanaç Zeren

Prof. Dr., Faculty of Architecture, Department of Architecture

İzmir, Buca, Türkiye

ORCID: 0000-0003-4803-9476

ABSTRACT

The aim of the study titled “Multi-layered Readings of the Ancient City of Stratonikeia” is to examine how architectural elements and structures belonging to different layers—encountered in settlements continuously inhabited since antiquity—were shaped and situated according to the characteristics of the city, and to determine whether relationships can be established between superimposed architectural layers. While geographical factors constitute the primary determinants, the study also investigates how stratification in ancient cities and the changing uses of architectural structures across periods might be influenced by additional variables, or whether, in some cases, no meaningful relationship can be established between these layers at all. The research, therefore, aims to analyze potential interrelated layer relationships within the stratigraphy of Stratonikeia—one of the Carian cities—and it attempts to identify comparable relational patterns by drawing references from other Carian settlements.

The methodological approach of the study relies primarily on literature research and comparative analysis. As main sources, Karialılar was used for the preliminary survey and comparative framework regarding the Carian cities, while Stratonikeia (Eskihisar) ve Kutsal Alanları served as the principal reference for chronological and historical information on Stratonikeia. During the research process, a field survey was conducted, supported by photographic documentation and two-dimensional technical drawings. Layer locations were expressed through color-coded graphical representations based on existing drawings. For comparative analysis, the ancient cities of Mylasa, Halikarnassos, Aphrodisias, Knidos, Iasos, Kaunos, Latmos Herakleia, Alinda, and Gergakome—distributed across the provinces of Muğla and Aydın—were investigated. The analysis centered on the historical periods (or chronological ranges) of these cities since their known foundations, as well as the architectural structures constructed during each period. The stratigraphic readings and architectural planning characteristics of these Carian cities provided the references for the analysis of the layers in Stratonikeia.

*This study is based on ongoing research for a master’s thesis entitled “Understanding Chronological Layers of Archaeological Sites and Their Spatial Relations: The Case of Stratonikeia Ancient Site”. The presentation will be based on the preliminary results of the findings.

Keywords: Stratonikeia, multi-layered, archeology, Caria, ancient city

PERIODICAL ANALYSIS OF SPATIAL DESIGN IN DEDEMLI VILLAGE TRADITIONAL HOUSES WITH SPACE SYNTAX

Raziye Çınar

Department of Architecture, Faculty of Art, Design and Architecture, Alanya Alaaddin Keykubat University

Antalya, Türkiye

ORCID: 0000-0002-4704-7303

Zafer Kuyrukçu

Department of Architecture, Faculty of Architecture and Design, Konya Technical University

Konya, Türkiye

ORCID: 0000-0001-6454-7484

ABSTRACT

Traditional houses are place-specific structures that continue to exist in cultural continuity from past to present, shaped in accordance with local data such as topography, climate, historical and experiential accumulations, everyday lifestyles of the people, socio-economic and socio-cultural statuses.

In this study, spatial design in traditional houses was considered in the context of the Dedemli Village sample area. Dedemli Village is a rural mountain settlement in the Hadim district of Konya. Due to the completion of the Bozkır Dam in 2020, this settlement area is expected to be submerged. Therefore, it is essential to conduct studies on documentation and detection in the area. Space organization in traditional houses in Dedemli Village is discussed within the framework of identifying periodical differences through the original stone structures dating back to the 1930s in the settlement area and the structures that emerged after 1985. In this context, the spatial organizations, analyzed in terms of period, were examined using the Space Syntax method, which provided a proven framework for the study. Based on this, the spatial organization of 20 original houses dated to the 1930s and 5 houses after 1985 were discussed using the Space Syntax method on 4 main parameters, namely "connectivity, integration, gate count and intelligibility". In this context, field work was carried out in the region and architectural survey work was carried out in a total of 25 houses and identity cards were created for the houses.

How the spatial structure developed in original traditional structures and how these structures evolved have been evaluated. In line with the findings obtained, the spatial configurations of traditional Dedemli Village houses, shaped by local, cultural and traditional experiences, and the spatial configurations of the structures after 1985, have been discussed on a numerical and provable basis. When the analysis results were examined, it was found that spatial design was more connected, integrated and intelligible in the original residences and that the possible spatial usage density (gate count) in the spaces was higher; while in the post-1985 residences, the connectivity, integration and intelligibility of spatial design were weaker and the possible spatial user density (gate count) was less. Therefore, it has been determined that the production codes such as needs, functionality and local data in traditional houses have created more efficient spatial organizations and relationships, while weaker spatial relationships have been formed in structures built after 1985.

Consequently, centuries-old traditional production codes, local data, accumulated knowledge, traditions, and cultural influences must be carefully considered in new building productions. It is crucial to shape the use of contemporary techniques and materials in accordance with these traditional codes, while preserving place-specific identities and healthy spatial structures.

Keywords: Dedemli Village, periodical analysis, Space Syntax, spatial design, traditional housing

ANALYSIS OF USKUDAR MIHRIMAH SULTAN MADRASA AND EDIRNEKAPI MIHRIMAH SULTAN MADRASA USING SPACE SYNTAX METHOD

Ahmet Şamil Çankaya

Master's Student, Fırat University, Faculty of Architecture, Department of Architecture

Elazıg, Türkiye

ORCID: 0009-0000-4516-6248

Muhammet Kurucu

Assistant Professor, Fırat University, Faculty of Architecture, Department of Architecture

Elazıg, Türkiye

ORCID: 0000-0001-5088-2863

ABSTRACT

Madrasahs, which are at the center of education and training activities in Islamic civilization, functioned as basic educational institutions. Etymologically, the concept of Madrasa is derived from the root 'lesson', meaning "to read, understand, learn and memorize a text". While the term "school" was used in the Arabian Peninsula for spaces built to spread and teach Islam, they were defined as "medrese" in Anatolia. Madrasahs were one of the most important building types that the Turks contributed to architectural literature during the Islamic period. Madrasahs were defined as places where Turks continued their educational activities, especially during the Karakhanid period, and were institutionalized in Turkish-Islamic history. Since the founding of the Ottoman Empire, madrasahs, established for the needs of the state and the education of society, provided great benefits to the Ottoman Empire in terms of the development of both the empire and the cities.

Madrasah building, which appear as educational structures during the Ottoman Period, were shaped by acquiring new styles through the synthesis of the architectural experiences of previous civilizations. Mimar Sinan, who represents an important period in Ottoman architecture, systematised these earlier styles and gave them a new direction. Mimar Sinan built many madrasas. It is known that there are 57 madrasahs belonging to Mimar Sinan in Istanbul, and in recent studies it has been determined that 19 of the existing madrasahs have been re-functioned. This study examines the spatial configurations and interactions between spaces of two important educational structures in Istanbul, Uskudar Mihrimah Sultan Madrasah and Edirnekapı Mihrimah Sultan Madrasah, which still exist today and reflect different periods and analyses of Mimar Sinan's mastery.

The purpose of the study; examine the integration and interaction between spaces in the Uskudar Mihrimah Sultan Madrasa and the Edirnekapı Mihrimah Sultan Madrasa. The study aims to evaluate these aspects specifically for the madrasahs examined. The madrasa plans determined within the scope are analyzed using the space syntax method. Connectivity analysis, a space syntax value, was applied to reveal the relationship of each space in the examined madrasahs with other spaces. To mathematically concretize the spatial data in the study, space syntax analyses were performed on two-dimensional plan drawings of the selected spaces using the 'depthmapx' program. The data and results obtained from the study have been evaluated.

Keywords: Madrasah, Mimar Sinan, Space Syntax

AN EXAMINATION OF THE SPATIAL ORGANIZATION OF MIMAR SINAN'S ICONIC MOSQUES AND THE CONTEMPORARY ÇAMLICA MOSQUE USING SPACE SYNTAX

Şeydanur Beroje

Department of Architecture, Faculty of Architecture, Fırat University

Elazığ, Türkiye

ORCID: 0009-0009-6936-1932

Muhammet Kurucu

Department of Architecture, Faculty of Architecture, Fırat University

Elazığ, Türkiye

ORCID: 0000-0001-5088-2863

ABSTRACT

Mimar Sinan, one of the most prominent figures of Ottoman architecture, constructed approximately 400 structures, among which his mosques stand out with their original plan schemes, dome configurations, and support systems. Sinan's mosques were conceived not only as places of worship but also within their social and urban contexts; each mosque was designed with distinct plan schemes and spatial organization strategies. In this regard, the spatial organization of these mosques is worth examining in terms of both the efficiency of interior functional arrangements and their symbolic positioning within the urban fabric. In the existing literature, studies that analyze the spatial organization of Sinan's mosques through quantitative methods are limited to visual or plan-based evaluations.

This study aims to systematically analyze the spatial organization of the Şehzadebaşı (apprenticeship period), Süleymaniye (journeyman period), and Selimiye (mastery period) mosques, as well as the contemporary Çamlıca Mosque, using the space syntax method. The inclusion of the Çamlıca Mosque in the scope of analysis enables a comparative evaluation of the spatial configuration between the classical mosque typology of the Sinan era and contemporary mosque architecture. The Çamlıca Mosque's location on a dominant hill in Istanbul and its formal and iconographic references to classical Ottoman architecture highlights the structure as a "representation and reinterpretation of the past in the present." Therefore, comparing Sinan's original design logic with the spatial organization of a modern mosque such as Çamlıca is significant for understanding how traditional architectural language is reproduced or reinterpreted in contemporary mosque design. In this study, the plans of all selected mosques were drafted, and connectivity, integration, and spatial depth values were computed through the DepthMapX software. Based on quantitative data, both the evolution of Sinan's spatial design across his career and the ways in which a historical architectural tradition is translated into contemporary mosque design were evaluated.

The analyses reveal the role of centrality and dome configuration in establishing spatial coherence in Sinan's mosques, while also demonstrating how large scale, multifunctionality, and a complex circulation system influence space syntax parameters in the Çamlıca Mosque. This comparison provides important insights into the extent to which contemporary mosque architecture preserves, reproduces, or transforms the historical mosque typology. The findings of the study provide new contributions to the literature on the spatial organization of Ottoman mosque architecture and the modern Çamlıca Mosque, demonstrating the comparability of historical and modern mosque typologies through quantitative analyses. Moreover, by demonstrating the applicability of quantitative methods for plan and spatial analysis, the study provides scientific data relevant to conservation, adaptive reuse, and modern mosque design. In conclusion, this research establishes a methodologically and theoretically valuable framework for both architectural history and current design practices.

Keywords: Space Syntax, Mimar Sinan, Ottoman Mosque Architecture, Çamlıca Mosque.

THE TRANSFORMATION OF TOURISM ARCHITECTURE TYPOLOGIES IN PALM JUMEIRAH: ANALYSIS OF MEGA RESORT COMPLEXES, LIFESTYLE-ORIENTED LUXURY HOTELS AND BOUTIQUE LUXURY PROPERTIES

Gökçe Demirpençe Özdoğan

Dokuz Eylül Üniversitesi

İzmir, Türkiye

İnci Uzun Mortan

Dokuz Eylül Üniversitesi

İzmir, Türkiye

ABSTRACT

Dubai's tourism-driven development model has repositioned architecture from a physical production practice into a strategic instrument of consumption-based representation. This shift has enabled the emergence of artificial islands that reconfigure the relationship between rapid consumption cycles, experiential demand and spatial design. Within this context, Palm Jumeirah—Dubai's most tourism-intensive artificial island—offers a distinctive environment in which the spatial, economic and cultural dynamics of luxury tourism can be examined through its iconic palm-shaped morphology.

Between 2008 and 2023, twenty-four hotel developments were completed on the island, each differing in scale, architectural language, thematic orientation and experiential configuration. This study classifies these hotels into three categories—mega resort complexes, lifestyle-oriented luxury hotels and boutique luxury hotels—drawing on international tourism typologies, upper-scale planning strategies and experience-driven consumption dynamics.

Mega resort complexes constitute the most dominant typology on the island. Projects such as Atlantis The Palm, Anantara The Palm, Jumeirah Zabeel Saray and Rixos The Palm operate as fully integrated resorts featuring thematic gardens, lagoon systems, aquariums, extensive spa facilities and gastronomic destinations. Their spatial logic creates self-contained tourism ecosystems that minimize interaction with the urban surroundings and channel visitor activity inward. The architectural configuration of these complexes prioritizes controlled circulation, optimized consumption flow and multi-layered experiential staging.

In contrast, lifestyle-oriented luxury hotels focus less on operational scale and more on social atmosphere, brand identity and contemporary aesthetics. Examples including Five Palm Jumeirah, W Dubai – The Palm and Rixos Premium Dubai JBR target a young, global and affluent audience through concepts shaped by beach culture, gastronomy-centered leisure and visually curated "instagrammable" environments. Architecture in this typology functions as both a spatial setting and a generator of social identity.

Boutique luxury hotels provide a quieter, more intimate and personalized form of high-end tourism. Properties such as Bulgari Resort, Adagio Premium and Wyndham Residences employ limited room capacities, distinctive architectural character and carefully curated programs to create environments where privacy and close interaction with the immediate context are central.

Overall, Palm Jumeirah exemplifies a multi-layered production model in which architecture, landscape design, branding strategies and experiential curation intersect with large-scale economic investment. The three typologies examined in this study reveal the spatial and socio-cultural orientations that collectively define tourism architecture on the island.

Keywords: Palm Jumeirah, Artificial Nature, Tourism, Consumption, Hotel Architecture.

FROM INDUSTRY TO CULTURE: A COMPARATIVE STUDY ON SUSTAINABILITY IN ADAPTIVE REUSE OF INDUSTRIAL HERITAGE PROJECTS

Sude Yavuz

Institute of Science, Department of Architecture, Trakya University

Edirne, Türkiye

ORCID: 0009-0001-3199-762X

Dinçer Aydın

Department of Architecture, Trakya University

Edirne, Türkiye

ORCID: 0000-0001-8436-6330

ABSTRACT

Industrial buildings constructed at the turn of the 19th and 20th centuries display spatial characteristics that responded to the industrial needs of the period, including steel frame systems and open-plan production areas, providing a design approach that met functional requirements but also increased production efficiency. Over the decades, advancements in production technologies have left many of these structures derelict, resulting in abandonment and exposure to potential demolition. The use of adaptive reuse as a tool for heritage conservation and sustainable urban development creates opportunities to reimagine these buildings as focal points within the urban environment. Globally, through the efforts of organizations such as ICOMOS, established frameworks have increasingly recognized adaptive reuse to reintegrate industrial heritage into contemporary life, aligning with sustainability objectives.

This study examines the environmental, sociocultural, economic performance and sustainability of five industrial heritage buildings: Santral Istanbul (TR), Art Istanbul (TR), Tate Modern (UK), Westergasfabriek (NL), and Zollverein Coal Mine (DE), selected based on the similarity of their original and current functions, and their applicability and relevance to each other and the subject matter. For the comparison of these cases, a structured set of criteria was developed to systematically assess the performance of these buildings across the identified sustainability dimensions. Key sub-criteria for the comparative analysis include improvements in energy efficiency, enhancing social and economic resilience and structural interventions. The criteria were defined through a comprehensive literature review, ensuring alignment with international conservation and sustainability standards.

Findings indicate that successful adaptive reuse projects balance the preservation of historical authenticity with the creation of social and cultural centers, while incorporating contemporary technologies to reduce environmental impact and generate financial benefits. This demonstrates that adaptive reuse efforts extend beyond conservation, serving as a catalyst for cultural revitalization and socioeconomic development. The insights from the analysis inform a set of evaluation criteria for assessing and guiding future adaptive reuse initiatives, highlighting the intersection of preservation, sustainability, and functional innovation.

By integrating theoretical perspectives with empirical examples, this research highlights the transformative potential of adaptive reuse as a multidimensional sustainability strategy for preserving industrial heritage while contributing to environmentally conscious practices, social engagement, and economic revitalization. The study also demonstrates that aligning design interventions with internationally recognized sustainability goals ensures the protection of heritage and its functional relevance in contemporary urban contexts.

Keywords: Industrial heritage, adaptive reuse, sustainability, sustainability dimensions, cultural centers.

BIBLIOMETRIC ANALYSIS OF USER-CENTRED APPROACHES IN SUSTAINABLE FACADE SYSTEMS

Neslihan Gül

Architecture, Dokuz Eylül University

Izmir, Türkiye

ORCID: 0009-0005-7285-2549

Gizem İzmir Tunahan

Architecture, Dokuz Eylül University

Izmir, Türkiye

ORCID: 0000-0003-1473-9351

ABSTRACT

In sustainable architecture, façade systems have traditionally been evaluated through physical criteria such as thermal performance, energy efficiency, and climatic response, while users' perceptual experience, behavioural responses, and interaction with space have remained secondary. The rapid spread of adaptive and user-interactive façade technologies demonstrates that frameworks based solely on technical metrics are no longer sufficient to explain contemporary design practices; façade performance must be interpreted through the full spectrum of interaction established with users. This study addresses this gap by examining the current state of research on user-centred façade systems, focusing on human–space interaction through a comprehensive bibliometric analysis.

A keyword set covering user behaviour, perceptual experience, adaptation, and interaction with façade systems was used to conduct searches in the Web of Science (WoS) and Scopus databases. Research articles and review papers in English were included, and duplicate records were removed, resulting in 810 unique publications. These were analysed using Bibliometrix/Biblioshiny to identify annual publication trends, international and institutional collaborations, author productivity, network structures, keyword co-occurrences, and thematic developments. Findings show that user-centred façade research has gained clear momentum since 2015, with research output concentrated in China, the United States, the United Kingdom, and the Netherlands. Collaborations highlight the influential roles of Delft University of Technology, Hong Kong Polytechnic University, and Eindhoven University of Technology.

Thematic evaluations reveal that the field remains dominated by technical topics such as thermal comfort, energy efficiency, and building envelope, whereas human-centred themes including behaviour, perception, sense of control, and adaptation hold lower centrality and remain secondary. This indicates that although technical performance studies continue to shape the field, research on user experience and human–façade interaction is still fragmented, limited, and lacking an integrated theoretical foundation. Trend analyses confirm rising interest in behavioural and perceptual themes, yet these remain emerging and underdeveloped areas.

Overall, the findings show that technical performance-oriented approaches continue to dominate façade systems research, while user behaviour, experience, and perception constitute the most critical and persistent gaps. The results demonstrate that façade performance cannot be meaningfully understood through physical parameters alone; it must be evaluated together with users' spatial experiences, behavioural patterns, and interaction practices. This underscores the need for a shift toward user-centred frameworks, which represent a fundamental yet largely unmet requirement for advancing both the theoretical and practical development of façade system research.

Keywords: user-centred design, adaptive façade, sustainability, human–space interaction, thermal comfort.

DISCUSSION OF THE STANDARDIZATION OF ARCHITECTURE THROUGH THE GOVERNMENT OFFICES

Emine Yıldız Kuyrukçu

Department of Architecture, Faculty of Architecture and Design, Konya Technical University

Konya, Türkiye

ORCID: 0000-0002-5794-3507

Mücahit Akbaş

Department of Architecture, Institute of Graduate Studies, Konya Technical University

Konya, Türkiye

ORCID: 0009-0001-2927-5580

ABSTRACT

Public buildings, which play a key role in urban identity, must have periodic features. However, on the facades of recent public buildings, we often see the repeated use of elements from historical periods, labeled as 'Ottoman' and 'Seljuk' architecture. Government offices, especially those built since the early 21st century, have become the most common buildings in this style. Yet, the facades of government offices, which serve as symbols of prestige for their cities and the power of the state, should be unique and meet the aesthetic needs of their users.

Government offices, as public buildings, hold a significant place in political, administrative, and social life as the most visible symbols of the state's provincial organization. These buildings are not only spaces where bureaucratic activities are conducted, but also reflect the ideological, cultural, and aesthetic understandings of their respective eras. This makes it important to question the facade-identity compositions of government offices, which are so important for the city's identity. Based on this, this study discusses the façade development of government offices from the past to the present, and questions the façade design of particularly recent government offices, and analyzes whether the façades of these buildings reflect the dominant ideology. For this purpose, the façade compositions of ten government offices constructed at the beginning of the 21st century and located in different regions were analyzed. The analyses revealed that, because they serve as common spaces where the public and the state meet, government offices reflect the dominant ideology of the period and the 'historicity' interpretation shaped by this ideology.

In conclusion, it is certainly beneficial to evaluate the essence of the Ottoman and Seljuk Empires. This is a well-intentioned approach, but it would be more accurate to grasp the proportions, imagery, essence, and spirit of these buildings and then incorporate them into the new design. Public buildings contribute to the city in cultural and aesthetic dimensions by reflecting the period, geography, and lifestyle to which they belong in architectural spaces. Cultural and historical sensitivity should not be repeated in today's buildings, but rather should be internalized and interpreted. In the design of these buildings, attention should be paid to adopting sustainable design principles that integrate with the city and establish a balanced relationship between historical heritage and modern needs.

Keywords: Public buildings, government offices, façade, identity, historicism

ON THE DENSE WATER FORMATION OF THE BLACK SEA

Bozkurt Burak Özhan

Dokuz Eylül University, Institute of Marine Science and Technology

İzmir, Türkiye

ORCID: 0000-0003-1261-8636

Şükrü Turan Beşiktepe

Dokuz Eylül University, Institute of Marine Science and Technology

İzmir, Türkiye

ORCID: 0000-0002-9615-4746

ABSTRACT

Deep waters form when surface waters cool, become denser, and sink. Water becomes denser with higher salt content or with colder temperatures. The importance of the basic mechanisms underlying the formation of deep and bottom waters has long been recognized for a general understanding of the world ocean and its dynamics and thermodynamics. In this study, based on past and recent observations from the Black Sea, a model of dense water formation and its fate in the deeper layers is developed. The distribution and properties of deep and bottom waters in the Black Sea are obtained. The Massachusetts General Circulation Model (MITgcm) is used to analyze deep-water formation in the Black Sea (27.30°E; 31.13°E; 41.55°N: 43.65°N). The bathymetry of the western coast of the Black Sea is obtained from the General Bathymetric Chart of the Oceans (GEBCO). Initial files are obtained from the Copernicus Marine Environment Monitoring Service (CMEMS), and forcing files are obtained from the European Centre for Medium-Range Weather Forecasts ReAnalysis 5 (ERA5). The processes governing dense water formation in the Black Sea during the 1993–1994 period are investigated. The analysis highlights the roles of wintertime surface cooling, variations in salinity driven by river discharge and localized evaporation, and vertical mixing induced by the zonal and meridional wind components (Rim Current dynamics). Owing to the high density of the deep Black Sea waters, driven by elevated salinity and a persistent anoxic layer, deep convection is inhibited. Therefore, the transformation and ventilation of water masses are examined within the Cold Intermediate Layer (CIL), where the effects of seasonal dense water formation are most clearly manifested.

Keywords: Dense water formation, black sea, MITgcm, fluid dynamics

PHYSICALLY DRIVEN UNCERTAINTY IN MARINE ECOSYSTEMS: EVIDENCE FROM ENTROPY DYNAMICS IN A STOCHASTIC NPZD FRAMEWORK

Müjdat Aydın

Institute of Marine Sciences and Technology Dokuz Eylul University

Haydar Aliyev Blvd. No:32, 35330 Inciralti, Izmir, Türkiye

ORCID: 0000-0002-2487-7689

Şükrü Turan Beşiktepe

Institute of Marine Sciences and Technology,Dokuz Eylul University

Haydar Aliyev Blvd. No:32, 35330 Inciralti, Izmir, Türkiye

ORCID: 0000-0002-9615-4746

ABSTRACT

In oceanographic modeling, performance is traditionally evaluated using deterministic metrics such as the Root Mean Square Error (RMSE). While such metrics quantify the magnitude of prediction errors, they offer limited insight into the physical mechanisms that generate those errors, the system's inherent "limits of knowability," and the constraints that the physical environment imposes on the model's information-processing capacity. This study employs a stochastic NPZD (Nutrient–Phytoplankton–Zooplankton–Detritus) model for the central open waters of the Black Sea, incorporating time-varying parameters and a first-order autoregressive (AR1) structure to preserve the temporal persistence (ecological memory) of biological processes. Shannon Entropy, derived from the posterior probability distributions of all state variables (N, P, Z, D), is introduced as a complementary diagnostic indicator for quantifying ecosystem predictability.The central finding of this work is that ecological uncertainty, expressed as entropy, is not purely stochastic but exhibits a statistically significant and physically regulated structure. Analysis of the 2015–2018 period reveals a robust positive correlation between Mixed Layer Depth (MLD) and model entropy ($r = 0.51$). This indicates that winter deepening of the mixed layer—driven by storms and convective mixing—weakens the deterministic coupling between surface and subsurface processes. As a result, heightened physical variability obscures the biological memory preserved by the AR(1) structure, diminishing information content and imposing predictability limits.Conversely, a strong negative relationship between Sea Surface Temperature (SST) and entropy ($r = –0.76$) demonstrates that thermally stratified spring–summer conditions introduce physical stability, decoupling biological signals from physical noise. Under these quiescent conditions, the model reconstructs ecological dynamics with notably greater precision, reflected in substantially lower entropy values. Together, these results establish a novel and fundamental Principle of Physically Controlled Uncertainty, which posits that physical variability governs—and inherently limits—biological predictability in marine ecosystems.Additionally, the Mann–Kendall trend test confirms a significant declining trend in entropy ($p < 0.001$), indicating that despite episodic physical disturbances, the model progressively reduces uncertainty through data assimilation. This finding supports the idea that the model extends beyond instantaneous curve-fitting and actively learns system dynamics over time, consistent with ecological inertia. Overall, this study elevates entropy from a simple error descriptor to a diagnostic oceanographic variable, reframing ecosystem modeling as a tool for quantifying the physical boundaries of ecological knowability.

Keywords: Stochastic NPZD modeling, Shannon entropy, Ecological predictability

NEXT-GENERATION ULTRASONIC INSPECTION TECHNOLOGIES FOR IMPROVING HATCH COVER TIGHTNESS MEASUREMENT ACCURACY IN MARITIME OPERATIONS

Karahan Karakurt

Maritime Faculty, Dokuz Eylul University

İzmir, Türkiye

ORCID: 0009-0002-6050-4641

Kadir Emrah Erginer

Maritime Faculty, Dokuz Eylul University

İzmir, Türkiye

ORCID: 0000-0002-2227-3486

ABSTRACT

Maintaining hatch cover watertightness is crucial for maritime safety and cargo protection. According to the International Maritime Organization (IMO) and the International Association of Classification Societies (IACS), hatch covers must be periodically tested to ensure they remain weathertight under operational conditions (IMO, 1966; IACS, 2022). P&I club reports indicate a significant share of cargo damage stems from water ingress via faulty hatch covers (Skuld, 2019). While traditional methods like hose and chalk tests are still employed, they present limitations in sensitivity, practicality, and repeatability. In contrast, ultrasonic testing has become a preferred alternative due to its non-destructive, operator-friendly, and quantifiable nature (Steamship Mutual, n.d.; Entech Quality, n.d.). It allows the detection of microscopic leaks without wetting the cargo or interrupting operations. Ultrasonic hatch cover testing involves placing a transmitter inside the hold to emit high-frequency sound (around 40 kHz). Leaks are detected using a handheld receiver that measures sound escaping through compromised seals. Devices like Cygnus Hatch Sure (with 19 elements) and Coltraco's Portascanner® offer high sensitivity (down to –30 dB) and precise leak localization (Cygnus Instruments, n.d.; Coltraco, n.d.). Classification societies, under IACS UR Z17 and similar guidelines, accept ultrasonic results for operational inspections, provided the equipment is certified. The commonly accepted criterion is that leakage exceeding 10% of the Open Hatch Value (OHV) indicates insufficient sealing (IMO, n.d.). Many P&I clubs request ultrasonic reports before loading, as they provide more reliable assessments than hose testing (Skuld, 2019). Recent innovations have broadened ultrasonic inspection capabilities. Acoustic imaging devices like SDT's HATCHecker and drone-integrated systems by Crysound enable real-time sound visualization and remote scanning of hard-to-reach areas (Crysound, n.d.; SDT, n.d.). Additionally, platforms like Coltraco's AIRTIGHT allow digital mapping of leaks with photographic overlays and generate standardized reports, enhancing traceability and legal robustness. Research continues on integrating fiber-optic sensors and digital twin platforms to enable real-time structural assessments during voyages (Springer, 2025; MDPI, 2023). Despite its growing adoption, further academic work is needed to standardize leak criteria, improve modeling accuracy, and advance surveyor training. In conclusion, ultrasonic hatch cover testing offers a scientifically sound and regulation-compliant method for maintaining watertight integrity. Its evolution—through acoustic imaging, digital diagnostics, and real-time monitoring—supports proactive maintenance and safer maritime operations.

Keywords: Hatch cover tightness, Maritime safety, Ultrasonic leak detection, Acoustic imaging, Cargo damage

MATHEMATICAL MODELING OF HEART FAILURE USING MACHINE LEARNING METHODS

Zahide Erva Bilen

Department of Mathematics, Yildiz Technical University

Istanbul, Türkiye

ORCID: 0009-0006-7942-5467

Filiz Kanbay

Department of Mathematics, Yildiz Technical University

Istanbul, Türkiye

ORCID: 0000-0003-3889-6351

ABSTRACT

There are studies in literature using machine learning algorithms to improve disease diagnosis. The aim of this study is to develop a model capable of classifying mortality/survival on the data of heart failure patients using machine learning algorithms and to identify features that have a high impact on model success. In this study, the "Heart Failure Clinical Records" dataset, consisting of 12 attributes (age, creatinine phosphokinase, ejection fraction, platelets, serum creatinine, serum sodium, anemia, high blood pressure, diabetes, sex, smoking) and 299 observation units obtained from UCI Machine Learning Repository website, was used. This dataset, which includes the medical records of heart failure patients, was collected by Ahmad and his colleagues. The mortality status of heart failure was analyzed on this dataset using machine learning algorithms, such as Naive Bayes, K-Nearest Neighbor, Decision Tree, Random Forest, Support Vector Machines, XGBoost, AdaBoost, Logistic Regression, and Artificial Neural Networks, along with libraries like Pandas, NumPy, Matplotlib, Seaborn, and scikit-learn libraries in the Jupyter Notebook environment using the Python programming language. The hyper-parameters that will maximize the success of the algorithms were determined by applying 5-fold cross validation and grid search to the dataset divided as 80% by 20%. These hyper parameters were evaluated across the entire dataset using ROC curve and Wilcoxon test methods, along with the weighted accuracy, precision, sensitivity, and f1-score metrics. Considering the evaluations made, the most successful model was found to be XGBoost algorithm. In addition, model successes after SMOTE method, which generates synthetic data points to eliminate dataset imbalance, were examined. Moreover, to observe how model performance changes with respect to the number of features in dimension reduction methods, a line graph was created using the algorithm with the highest performance at each cycle, based on progressively decreasing feature counts with various feature selection and feature extraction techniques. Features that have a high impact on model success were identified, the distribution of these features in the dataset was examined with a box plot, and a decision tree structure capable of classifying mortality/survival based on two most effective features was created. As a result of this study, medical data of heart failure patients were evaluated within the scope of machine learning methods. The findings obtain in the study are expected to contribute to improving decision-making mechanisms in the health sector.

This work has been supported by Yildiz Technical University Scientific Research Projects Coordination Unit under project number FYL-2025-7048.

Keywords: Machine Learning, Heart Failure, Feature Selection, Feature Extraction

EMPIRICAL NARRATIVE ENGINEERING: A NEURO-SYMBOLIC ARCHITECTURE FOR STRUCTURED STORY GENERATION

Mücahit Söylemez

Department of Management Information Systems, Istanbul University

Istanbul, Türkiye

ORCID: 0009-0009-0059-616X

ABSTRACT

This study presents a hybrid "Neuro-Symbolic" architecture developed to overcome problems such as structural amnesia, circular repetitions, and thematic drift encountered by Large Language Models (LLMs) in long-form narrative generation. The system integrates a "System 2" planner based on a 1st-order Markov Chain-trained on a dataset of 211,052 scenes distilled from 2,819 classic works-with the Mistral-24B neural engine (System 1). Unlike the traditional "Next-Token Prediction" mechanism, this architecture ensures global plot integrity by grounding narrative generation on a probabilistic skeleton. Regulating the probability space according to literary norms through a "Surgical Intervention Layer" (including the y parameter, minimum length barriers, and forced climax injection), this method achieved a 32.5% increase in narrative sophistication (Flesch-Kincaid) and anchored genre fidelity (Sentiment: -0.50) to an empirical guarantee compared to linear inference models. The study documents the trade-off between creative freedom and structural discipline with quantitative metrics, proposing a scalable narrative engineering framework that manages the "black box" nature of LLMs with a statistical control mechanism.

Keywords: Narrative Generation, Neuro-Symbolic Systems, Markov Chains, Story Structure, Large Language Models

MULTI-AGENT AUTHORIZATION-ENABLED RETRIEVAL-AUGMENTED GENERATION FRAMEWORK

Halil Yesil

Department of Computer Science, Dokuz Eylul University

Izmir, Türkiye

ORCID: 0009-0001-6925-6472

Baris Tekin Tezel

Department of Computer Science, Dokuz Eylul University

Izmir, Türkiye

ORCID: 0000-0003-4873-7848

Moharram Challenger

Department of Computer Science, University of Antwerp

Antwerp, Belgium

ORCID: 0000-0002-5436-6070

ABSTRACT

Retrieval-Augmented Generation (RAG) systems improve language model abilities by integrating external knowledge. However, they face serious security issues when dealing with sensitive information in different organizations. Traditional RAG setups often lack strong access control, which creates risks with confidential documents, proprietary research, and sensitive visual content. This paper presents a new multi-agent RAG framework that implements dynamic, fine-grained access control using specialized autonomous agents. These agents work with pre-constructed knowledge bases and large language models to make smart security decisions.

Our framework uses a distributed structure with five specialized agents that collaborate. The RAG Orchestrator Agent manages the workflow to ensure the system operates smoothly. The Chunk Retrieval Agent carries out semantic search operations. It converts user queries into high-dimensional embeddings using the mxbai-embed-large model and retrieves the five most relevant document chunks from the poster content knowledge base by applying cosine similarity metrics. Two parallel Access Control Agents separately query text and image knowledge bases. They use the qwen2.5:72b language model to analyze user permissions according to document requirements. Each agent determines document accessibility based on the user's organizational affiliation, as determined by email domains, and assesses security clearance levels. The Decision Engine Agent combines outputs from both Access Control Agents. It uses qwen2.5:72b again to perform contextual reasoning about the combined permission results. This resolves conflicts and makes final authorization decisions before releasing information.

The multi-agent design offers benefits over unified setups by allowing independent operation with specialized knowledge bases. This enables parallel processing of access control checks. The strategic use of qwen2.5:72b at key decision points builds a strong multi-layered security system. The framework removes the need for manual database construction and extensive preprocessing, instead relying on language model reasoning for dynamic access decisions at every stage.

An evaluation involving 167 research posters from six Belgian institutions (University of Antwerp, Flanders Make, University of Ghent, University of Hasselt, KU Leuven, VUB) shows an overall accuracy of 93%, with 92% for text-based control and 78% for image-based control. The system maintains fast response times while ensuring that generated responses only contain authorized information. It proves effective for complex multi-organizational scenarios with different security levels. This research offers a scalable and secure RAG framework suitable for quick deployment in enterprises where information security is crucial.

Keywords: Retrieval-Augmented Generation, Multi-Agent Systems, Access Control, Information Security, Knowledge Bases

STOCHASTIC ANALYSIS OF GENE EXPRESSION SIGNALS DURING HUMAN NEURONAL DIFFERENTIATION USING RANDOM SIGNAL PROCESSING METHODS AND DETERMINATION OF SIGNAL STABILITY

Rümeysa Karaismailoğlu

Department of Informatics, İstanbul University Institute of Graduate Studies in Sciences

İstanbul, Türkiye

ORCID: 0001-8633-1510

ABSTRACT

In biological systems, gene expression is not a static process; rather, it possesses a dynamic structure exhibiting natural fluctuations over time. Traditional transcriptomic analyses typically focus on quantitative changes in gene abundance between two distinct conditions, often overlooking the stability or stochastic nature of signals across time series. The perspective that these fluctuations, termed "transcriptional noise" in the literature, represent a critical mechanism determining cell fate rather than mere experimental error is gaining increasing traction. In this study, gene expression data from the neuronal differentiation process of human embryonic stem cells (hESCs) were analyzed using Random Signal Processing (RSP) techniques, moving beyond classical statistical methods.

The study utilized the RNA-seq dataset (accession number GSE192855) retrieved from the NCBI Gene Expression Omnibus (GEO) database. This dataset was strategically selected due to its modeling of the neuronal differentiation process of human embryonic stem cells (hESCs) (Days 0, 7, 13, and 20) and its high-resolution representation of early neurogenesis stages. Data analysis was conducted using the Orange Data Mining platform integrated with Python algorithms, performing Lag-1 Autocorrelation (RSP Score) and Variance analyses. For each gene probe, variance values and the Lag-1 Autocorrelation coefficient (RSP Score)—which measures the relationship of the signal with its past values—were calculated. Based on these metrics, genes were classified as "deterministic signals" or "stochastic noise" according to their behavioral patterns across the time series.

The findings revealed that the signal behaviors within the gene pool are not homogeneous. It was determined that critical transcription factors and structural genes governing neuronal development possess high RSP scores (>0.90) throughout the time series, exhibiting a noise-free, stable "step response." Conversely, it was observed that the vast majority of genes exhibit random oscillations along the time axis rather than following a distinct developmental trend, demonstrating low signal stability (<0.20).

In conclusion, this study demonstrates that human brain development is not a random process; on the contrary, it is governed by a deterministic signal processing mechanism wherein the cell isolates vital genes from noise while relegating secondary processes to stochastic variations. The proposed RSP approach, which focuses on signal quality rather than merely gene quantity, could serve as an effective tool in future studies for eliminating noisy targets, particularly in drug target identification. Furthermore, measuring the capacity of drug candidates to enhance signal stability could represent a novel strategy for the treatment of neurodegenerative diseases.

Keywords: RNA signal processing, transcriptional noise, autocorrelation, human neurogenesis, bioinformatics

THE ROLE OF ANATOLIAN SWEETGUM (LIQUIDAMBAR ORIENTALIS MILL) OIL IN THE PENICILLIN MODEL OF EPILEPSY

Aya Shakfah

Department of Biology, Graduate School of Natural and Applied Sciences, Erciyes University

Kayseri, Türkiye

ORCID: 0009-0005-8125-2430

Abdulkadir Taşdemir

Department of Biology, Faculty of Science, Erciyes University

Kayseri, Türkiye

ORCID: 0000-0003-1196-457X

ABSTRACT

Epilepsy is a serious neurological disease characterized by sudden, recurrent seizures resulting from abnormal and excessive electrical discharges in cortical neurons. The penicillin model is a model of acute epileptiform activity often used in epilepsy studies. Penicillin reduces inhibition by blocking GABA receptors, thereby producing neuronal hyperexcitation and epileptiform discharges.

The Anatolian Sweetgum (*Liquidambar orientalis* Mill.) is an endemic tree found in southwestern Turkey that has managed to maintain its existence for centuries despite changing environmental conditions. Today, the oil obtained by wounding the trunk of the tree is used in many areas. *Liquidambar* species have various therapeutic uses due to their antimicrobial, antibacterial, antioxidant, antifungal, antitumor, anti-inflammatory, antiatherogenic, antituberculosis, and antimalarial activities, owing to the presence of cinnamic acids and esters. In traditional medicine, *L. orientalis* is preferred specially in healing damage such as gastritis and ulcers also used in the treatment of abdominal pain, skin diseases, lung diseases and paralysis.

The aim of this study was to evaluate the effect of intraperitoneally administered the oil on epileptiform activity when given after the activity had been induced. Epileptiform activity was investigated in three groups of rats. In the control group (n=10), anesthesia was induced with urethane and surgical procedures were performed, but no substance was administered, and electrophysiological recordings were taken for 180 minutes. In the Penicillin G group (n=10), anesthesia was induced with urethane, then 500 IU (2.5 µl, i.c) Penicillin G was administered, and electrophysiological recordings were taken for 180 minutes. In the penicillin plus storax oil group (n=10), anesthesia was induced with urethane, 500 IU Penicillin G was administered intracortically, and ten minutes later oil was given intraperitoneally, followed by 180 minutes of electrophysiological recordings. For all groups, screws were placed into the skull to allow electrical conduction and electrodes were fixed to the screw heads. Recordings were collected using BioAmp and PowerLab systems, and data were stored in LabChart software where spike frequency and amplitude analyses were performed. Minute-by-minute data were transferred to Excel, grouped into ten-minute intervals, and averaged to evaluate time-dependent changes. Statistical analyses were carried out using SPSS version 30. In conclusion, *Liquidambar orientalis* oil acted as a proconvulsant agent after epileptiform activity was induced with penicillin at a dose of 100 mg/kg. An anticonvulsant effect emerged towards the end of the ECoG recordings. This suggests, in the literature, that this oil increases activity due to its rapid resuscitation activity, and then reduces epileptiform activity due to the oil's active ingredient, cinnamic acid. Detailed molecular studies are needed to elucidate the proposed pathway.

Keywords: Epilepsy, penicillin model, Liquidambar orientalis

ANTIEPILEPTIC ACTIVITY OF STEM CELL-DERIVED EXOSOMES ON EPILEPSY

Berfin Uğur

Department of Biology, Graduate School of Natural and Applied Sciences, Erciyes University

Kayseri, Türkiye

ORCID: 0000-0001-5862-8835

Abdulkadir Taşdemir

Department of Biology, Faculty of Science, Erciyes University

Kayseri, Türkiye

ORCID: 0000-0003-1196-457X

ABSTRACT

Epilepsy is a chronic neurological disease characterized by the disruption of electrical communication between neurons, characterized by recurrent seizures and can lead to progressive neuronal damage over time. Affecting approximately 50 million individuals worldwide, current antiepileptic drugs mostly provide symptom control. Pharmacological treatment is inadequate, particularly in drug-resistant cases. The lack of a comprehensive treatment that can prevent epileptogenesis has brought stem cell-derived exosomes (SDEs) to the forefront of research in the field of regenerative medicine. Exosomes are nanometric vesicles that carry biological molecules such as miRNA, mRNA, protein, and lipid to target cells, thereby producing the therapeutic effects of cell-based therapies. This review presents a comprehensive assessment of the therapeutic roles of exosomes derived from different stem cell sources in epileptic models, based on current literature, based on their molecular composition, the signaling pathways they regulate, and their effects on epileptogenesis.

As part of the study, PubMed, Web of Science, Springer Nature, and ScienceDirect databases were searched using the keywords "stem cell-derived exosomes," "epilepsy," "neuroprotection," "mesenchymal stem cells," and "neuroinflammation." Studies in the literature indicate that Mesenchymal Stem Cell (MSC)-derived exosomes suppress reactive astrocytosis and inflammatory processes in experimental epilepsy models. The neuroprotective effects of exosomes have been reported to be associated with increased expression of anti-inflammatory cytokines and suppression of pro-inflammatory cytokines. In addition, stem cell exosome (SCE) administration has been found to contribute to the reduction of oxidative stress in serum. Cellular applications using human umbilical cord MSCs and exosomes can be used in the treatment of degenerative diseases such as epilepsy. In general, exosomes offer many practical advantages, such as convenient storage conditions, reproducible dosing, high stability, and low immune response compared to cell-based therapies.

Taken together, these data suggest that stem cell-derived exosomes have versatile biotherapeutic potential, including antioxidant, anti-inflammatory, neuroprotective, and neurogenesis-stimulating effects, suppressing epileptogenesis. Their safety, ethical acceptability, and technical feasibility compared to cell transplantation make exosomes a strong clinical candidate for the treatment of epilepsy. However, further preclinical and clinical studies are needed to determine the precise dose range, optimal route of administration, and long-term safety profile.

Keywords: Antiepileptic activity, stem cell, stem cell exosome

INVESTIGATION OF THE UBIQUITIN-MEDIATED REGULATOION OF SPEEDY/RINGO PROTEIN IN HIPPOCAMPAL NEURONAL CELLS

Selen Güneş

Department of Molecular Biology and Genetics, Mugla Sitki Kocman University

Mugla, Türkiye

ORCID: 0009-0006-4808-7776

Ayşegül Yıldız

Department of Molecular Biology and Genetics, Mugla Sitki Kocman University

Mugla, Türkiye

ORCID: 0000-0001-6356-7459

ABSTRACT

Neurodegeneration is a progressive process leading to neuronal death and synaptic impairment. The Speedy/RINGO (SPY1/SPDYA) protein has emerged as a significant molecule in this context due to its ability to inhibit apoptosis through p53-dependent pathways, marking it as a potential therapeutic target. Notably, reduced Speedy/RINGO expression observed in models of amyotrophic lateral sclerosis (ALS) suggests its turnover may be disrupted via the ubiquitin-proteasome system. However, while studies in non-neuronal cells indicate regulation by E3 ubiquitin ligases like Nedd4 and Skp2, the precise post-translational mechanisms governing Speedy/RINGO stability and activity in neurons remain completely undefined. This gap is critical, as E3 ligases such as Nedd4, Skp2, and Mdm2 are themselves implicated in neurodegenerative pathologies.

The primary objective of this study is to map the ubiquitin-mediated regulatory network controlling the Speedy/RINGO protein in hippocampal neuronal cells, a region profoundly affected in disorders like Alzheimer's disease. To achieve this, we will utilize hippocampal neuronal cultures transfected with a Speedy/RINGO expression vector. A multi-pronged experimental approach will be employed: (1) Western blot analysis to monitor expression levels of Speedy/RINGO, p53, and the candidate E3 ligases (Nedd4, Skp2, Mdm2). (2) Co-immunoprecipitation assays to investigate physical interactions between Speedy/RINGO and p53, as well as between Speedy/RINGO and each E3 ligase. (3) Assessment of the poly-ubiquitination status of Speedy/RINGO via immunoprecipitation to investigate its post-translational stability regulation.

We hypothesize that Speedy/RINGO's stability in neurons is controlled by a specific E3 ubiquitin ligase complex, likely involving Nedd4 or Skp2, and that p53 plays a crucial scaffolding or facilitating role in this interaction. The experimental design includes control groups (transfected with empty vector) and Speedy/RINGO-overexpressing groups. Following transfection, protein lysates will be used for immunoprecipitation with anti-Speedy/RINGO antibodies, and the precipitates will be probed with anti-ubiquitin antibodies to characterize modification patterns. Reciprocal co-IPs will further delineate the protein-interaction network.

The anticipated outcomes are twofold. First, this work will identify the principal E3 ubiquitin ligase responsible for Speedy/RINGO regulation in hippocampal neurons. Second, it will define the mechanistic role of p53 within this regulatory complex. These findings will provide fundamental insights into the post-translational homeostasis of a key neuroprotective factor. Ultimately, elucidating this regulatory axis opens new avenues for therapeutic intervention by identifying molecular targets to modulate Speedy/RINGO protein levels, thereby potentially mitigating neuronal loss in neurodegenerative diseases.

This study was supported by the TÜBİTAK 1001 Project No. 123S637

Keywords: Neurodegeneration, Speedy/RINGO, Ubiquitination, Hippocampal neurons

REGULATORY ROLE OF THE SPEEDY/RINGO PROTEIN ON DNA DAMAGE RESPONSE PROTEINS IN NEURONAL CELLS AND ITS IMPACT ON APOPTOSIS EVASION MECHANISMS

Şeyma Eroğlu

Department of Molecular Biology and Genetics, Mugla Sitki Kocman University

Mugla, Türkiye

ORCID: 0009-0007-5313-436X

Ayşegül Yıldız

Department of Molecular Biology and Genetics, Mugla Sitki Kocman University

Mugla, Türkiye

ORCID: 0000-0001-6356-7459

ABSTRACT

Neurodegeneration is a multifaceted and progressive pathological process characterized by irreversible functional decline and neuronal loss, driven by interconnected molecular disturbances including protein misfolding, calcium dyshomeostasis, mitochondrial dysfunction, oxidative stress, and accumulated DNA damage. In post-mitotic neurons that cannot proliferate or re-enter the cell cycle, age-related DNA lesions combined with reduced repair capacity serve as major triggers of apoptosis and neuronal vulnerability. Although Speedy/RINGO is known in mitotic cells for its oncogenic potential—mainly by suppressing the DNA damage response (DDR) and enabling p53-mediated apoptosis evasion—its functional role in differentiated neuronal cells remains largely unclear. Understanding whether this atypical cell-cycle regulator contributes to neuronal fate decisions under stress is therefore highly relevant to neurodegenerative disease research.

The central objective and novelty of this study is to translate a mechanism previously characterized in cancer biology into a neurodegenerative context by systematically analyzing the interactions of Speedy/RINGO with key DDR-associated proteins, namely ATM, ATR, Chk1, Chk2, and p53, in HT-22 and SH-SY5Y neuronal cell models. To emulate neurodegenerative stress, a Ca^{2+}-induced degeneration paradigm was established, followed by experimental modulation of Speedy/RINGO expression through plasmid-driven overexpression and siRNA-mediated knockdown. Subsequent analyses included cell viability assessment (MTS assay), quantification of oxidative stress (ROS determination), evaluation of DNA damage (Comet Assay and γH2AX immunodetection), apoptosis measurements, qRT-PCR-based gene expression profiling, and Western blot analysis of DDR pathway components.

Preliminary findings indicate that Speedy/RINGO exerts regulatory effects on the DDR in a cell-type-dependent manner, particularly through modulation of p53 and phosphorylated ATM (p-ATM). In HT-22 hippocampal neuron-like cells, Speedy/RINGO appears to maintain cell-cycle-associated signaling despite genotoxic stress, suggesting a survival phenotype analogous to apoptosis evasion observed in mitotic systems. Conversely, in SH-SY5Y neuroblastoma-derived cells, Speedy/RINGO influences a more balanced relationship between DNA repair and apoptosis, implying that its functional outcomes may be shaped by intrinsic cell-specific regulatory programs.

Collectively, these results suggest that Speedy/RINGO may function as a previously unrecognized modulator of DNA repair dynamics and cell-cycle-related processes in neuronal cells. By shaping apoptosis resistance, Speedy/RINGO could influence cellular responses linked to the onset or progression of neurodegenerative disorders. Clarifying this regulatory axis may offer valuable insights into neuronal stress biology and identify potential molecular targets for therapeutic intervention.

This study was supported by the TÜBİTAK 1001 Project No. 123S637

Keywords: Neurodegeneration, speedy/RINGO, ATM/ATR signaling pathways, apoptosis

INTEGRATED CRISPR-MICROFLUIDIC PLATFORM FOR AUTOMATED POINT-OF-CARE PATHOGEN DETECTION

Md. Hafijur Rahman

Department of Biomedical Technology, The Graduate School of Natural and Applied Sciences, Dokuz Eylul University

Izmir, Türkiye

ORCID: 0000-0003-4031-6475

Özge Cihanbeğendi

Faculty of Engineering, Department of Electrical and Electronics Engineering, Dokuz Eylul University

Izmir, Türkiye

ORCID: 0000-0001-7839-2954

ABSTRACT

The rapid and precise identification of infectious microorganisms and their antibiotic resistance markers is essential for effective disease surveillance, clinical diagnosis, and environmental monitoring. Current gold-standard methods, including polymerase chain reaction and culture-based tests, depend on advanced laboratory infrastructure and require lengthy processing, which limits their use in point-of-care and resource-constrained settings. Although CRISPR-based diagnostic platforms, such as the Sherlock Biosciences EUA assay for SARS-CoV-2 and Mammoth Biosciences' lateral flow formats, have expanded testing capabilities, they still rely on manual nucleic acid extraction, dedicated equipment, or provide only binary readouts, restricting broader deployment.

This work describes a portable biosensing platform that integrates CRISPR-Cas12a/Cas13a with microfluidic automation and dual-signal detection to identify pathogens directly from raw clinical and environmental samples. Sample preparation is fully automated within a single-use microfluidic cartridge using materials such as diatomaceous earth, followed by Loop-Mediated Isothermal Amplification (LAMP) at a constant temperature enabled by thermostable Cas variants. This integrated workflow removes the need for thermal cycling and reduces assay time. A dual-reporter system produces both fluorescent and electrochemical signals upon CRISPR-mediated collateral cleavage, increasing assay specificity by requiring agreement between the two outputs. The modular cartridge architecture supports rapid pathogen reprogramming through replaceable guide RNA units containing lyophilized CRISPR reagents and primers. The design can detect four different targets simultaneously and provides flexibility that current commercial assays lack, as those systems are usually limited to fixed targets and cannot be updated rapidly.

Furthermore, signal acquisition combines optical detection using LED-excited CMOS sensors with electrochemical measurements from a compact potentiostat, while a user-friendly smartphone interface processes the data in real time. The smartphone app reports quantitative metrics, confidence indicators, and geotagged results, all formatted for compatibility with global surveillance networks such as those maintained by the WHO. In addition, the formulation of lyophilized reagents ensures reagent stability of over four months at elevated temperature and humidity, which minimizes the cold-chain dependency for tropical and remote deployments.

This study outlines the preliminary steps required to develop an automated CRISPR–microfluidic diagnostic system capable of detecting pathogens directly from raw samples. By unifying isothermal amplification, CRISPR-driven signal generation, dual-mode readout, and smartphone-based analysis, this work establishes the foundations for a practical "sample-in, result-out" tool suitable for outbreak response and antimicrobial resistance monitoring.

Keywords: CRISPR, microfluidics, point-of-care testing, electrochemical sensing, LAMP amplification

IN VITRO EVALUATION OF THE THERAPEUTIC POTENTIAL OF GLIQUIDONE, A TYPE II DIABETES DRUG, FOR CANCERS HARBORING WILD-TYPE P53 THROUGH A DRUG REPURPOSING APPROACH

Elif Giçi

Department of Molecular Biology and Genetics, Mugla Sitki Kocman University

Mugla, Türkiye

ORCID: 0009-0004-0910-6722

Ayşegül Yıldız

Department of Molecular Biology and Genetics, Mugla Sitki Kocman University

Mugla, Türkiye

ORCID: 0000-0001-6356-7459

ABSTRACT

Cancer remains a significant cause of morbidity and mortality worldwide today. While current treatment approaches such as chemotherapy, immunotherapy, and cell-based therapies are effective in many patients, these methods have various limitations. Therefore, the development of more effective, safer, and targeted new treatment options continues to be a priority research area in modern cancer biology.

In this context, the Mouse Double Minute 2 (MDM2) protein, one of the regulators of the p53 tumour suppressor protein that plays a critical role in cellular growth, apoptosis, and DNA repair mechanisms, has become an important focus of research. MDM2 occupies a central position in regulating the cell cycle by negatively controlling p53; inhibition of p53 plays a decisive role in the development of various types of cancer. Therefore, the pharmacological targeting of MDM2 offers great potential for the development of new-generation anti-cancer treatments.

Within the scope of the proposed thesis, candidate molecules with high MDM2 inhibition potential were identified from among 5,883 FDA-approved drug molecules using Quantitative Structure-Activity Relationship (QSAR) modelling, molecular docking, and molecular dynamics simulations. These analyses revealed that the gliquidone molecule, used in the treatment of Type II Diabetes, exhibits a significantly high binding affinity to MDM2. The most important factor enhancing the original value of the study is that gliquidone has not been associated with the MDM2-p53 axis in the literature in terms of cancer treatment, particularly within the framework of drug repurposing.

Within the scope of the thesis proposal, it is planned to evaluate the anti-cancer activity of gliquidone in cancer cell lines expressing wild-type p53 using MTS/MTT colorimetric assays. Additionally, it is intended to investigate the effects of gliquidone administration on p53, MDM2, and the target genes of p53 (CDKN1A, BAX, and DDB2) at the transcriptional level using qRT-PCR. These analyses will provide a comprehensive molecular understanding of how gliquidone modulates the p53-MDM2 signalling pathways.

The aim with the results obtained is to present strong preclinical scientific evidence for the repositioning of gliquidone as a potential anti-cancer agent capable of affecting the MDM2-p53 axis. This approach will contribute to the evaluation of existing drugs in new therapeutic areas, offering significant advantages in terms of both time and cost. Therefore, the study aims to be an important step towards the development of innovative strategies in cancer treatment.

Keywords: Tumor suppressor protein p53, proto-oncogene MDM2, gliquidone, wild-type p53

INTEGRATIVE ANALYSIS OF SINGLE-CELL AND SPATIAL TRANSCRIPTOMICS DATA IN BREAST CANCER: A COMPARATIVE DECONVOLUTION APPROACH

Beste Uncu

Department of Statistics, Faculty of Science, Dokuz Eylul University

Izmir, Türkiye

ORCID: 0000-0001-7993-9165

İdil Yavuz

Department of Statistics, Faculty of Science, Dokuz Eylul University

Izmir, Türkiye

ORCID: 0000-0003-2163-1066

ABSTRACT

Spatial transcriptomics has emerged as a transformative technology for understanding tissue architecture and cellular organization in cancer biology. However, accurate cell type differentiation in spatial data remains challenging due to the limited resolution of current platforms and the complexity of tumor microenvironments. This study presents a comprehensive computational pipeline that integrates single-cell RNA sequencing (scRNA-seq) data from breast cancer samples with Visium spatial transcriptomics data obtained from the 10x Genomics public dataset, originally published by Wu et al. (2021, Nature Genetics).

We applied an integrated analytical framework that leverages annotated scRNA-seq data (>100,000 cells) as a reference to deconvolve cell-type compositions in spatially resolved transcriptomics data. Our pipeline implements three state-of-the-art deconvolution methods: SPOTlight, which employs non-negative matrix factorization for rapid cell-type estimation; RCTD (Robust Cell Type Decomposition), utilizing regression-based approaches for improved accuracy; and CARD (Cell-type Aware spatial Reconstruction and Deconvolution), which incorporates spatial neighborhood information for context-aware predictions.

The workflow encompasses comprehensive quality control, normalization using SCTransform, dimensionality reduction, and systematic comparison of deconvolution outputs. We generated spatial distribution maps for major cell types including epithelial cells, immune populations (T cells, B cells, macrophages), cancer-associated fibroblasts, and endothelial cells. Cross-method validation revealed strong concordance between methods for abundant cell types, while highlighting method-specific advantages for rare populations.

Our findings demonstrate that integration of multiple deconvolution approaches provides robust cell-type abundance estimates and reveals spatial organization patterns critical for understanding tumor-immune interactions. The modular pipeline structure facilitates adaptation to diverse tissue types and experimental designs, offering a reproducible framework for spatial transcriptomics analysis. This work contributes to the growing body of computational methods aimed at bridging single-cell and spatial omics data, with implications for precision oncology and biomarker discovery.

Keywords: Spatial transcriptomics deconvolution, scRNA-seq reference, Computational benchmarking, Statistical comparison, Breast cancer microenvironment

INTEGRATING REAL-TIME WHOLE-BODY RANGE OF MOTION ASSESSMENT INTO TELEREHABILITATION: A COMPUTER VISION APPROACH FOR THE STEPSMART AI PLATFORM

Asya Ası

Graduate School of Natural and Applied Sciences, Department of Biomedical Technologies,

Dokuz Eylul University

Izmir, Türkiye

ABSTRACT

Musculoskeletal disorders require consistent monitoring and rehabilitation exercises to ensure patient recovery. Telerehabilitation has emerged as a vital solution, bridging the gap between physical therapists and patients, especially for those with limited access to clinics. However, a significant limitation in current telerehabilitation platforms is the reliance on subjective patient self-reports rather than objective physiological data. While chatbot-based solutions utilize Natural Language Processing (NLP) to classify patient complaints, they often lack the capability to quantitatively assess whether the patient is performing movements correctly.

This study aims to address this gap by developing and integrating a real-time, vision-based Range of Motion (ROM) assessment module into the StepSmart AI ecosystem. Unlike complex video analysis methods that require heavy computational power or wearable sensors, this proposed module utilizes a standalone, geometry-based computer vision approach. The system is built using Python, OpenCV, and the MediaPipe holistic framework. It captures live video feed from a standard webcam to detect 33 skeletal landmarks on the human body without requiring any specialized hardware. The developed algorithm calculates angular measurements for major joints, including the shoulder, elbow, hip, and knee, in real-time. A graphical user interface (GUI) overlays these measurements on the live video stream, providing instant visual feedback to the user.

Preliminary tests conducted on the prototype demonstrated that the system successfully identifies joint centers and calculates angles with low latency, suitable for home use. The resulting ROM data provides an objective metric that can be used to track patient progress over time. This vision module serves as a critical upgrade to the StepSmart AI platform, transforming it from a text-based advisory tool into a comprehensive, multimodal telerehabilitation system. Future work will focus on validating these measurements against clinical goniometers and integrating the objective ROM data with the existing NLP engine to personalize exercise prescriptions dynamically based on the patient's physical limitations.

Keywords: Telerehabilitation, Computer Vision, Artificial Intelligence, Range of Motion, Remote Monitoring.

DIAGNOSTIC ACCURACY OF THE XPERT MTB/XDR ASSAY FOR DETECTION OF ISONIAZID AND SECOND-LINE ANTITUBERCULOSIS DRUGS RESISTANCE

Ahmet Selman Mızraklıdağ

Gaziantep University, Faculty of Medicine Deparment of Microbiology

Sehitkamil,Gaziantep, Türkiye

ORCID:0000-0002-8593-8529

Deniz Gazel

Gaziantep University, Faculty of Medicine Deparment of Microbiology

Sehitkamil, Gaziantep, Türkiye

ORCID: 0000-0003-2764-3113

Hatice Birgin

Gaziantep University, Faculty of Medicine Deparment of Microbiology,

Sehitkamil, Gaziantep, Türkiye

ORCID:0009-0003-8293-5175

ABSTRACT

Although rifampin and isoniazid are the main drugs used to treat tuberculosis (TB) caused by *Mycobacterium tuberculosis*, cases of rifampin-resistant tuberculosis also occur. In these cases, second-line drugs (ethionamide, fluoroquinolones, and injectable drugs (amikacin, kanamycin, and capreomycin)) are required. Routine rapid PCR tests can detect mutations leading to rifampin resistance, but they cannot detect resistance to isoniazid and second-line anti-TB drugs. The gold standard for detecting drug resistance is culture-based phenotypic testing (MGIT 960/agar proportion), which is time-consuming and requires experienced personnel. In resistant tuberculosis cases, rapid molecular tests capable of detecting resistance to isoniazid and second-line anti-TB drugs are needed.

Seven rifampin-resistant *Mycobacterium tuberculosis* isolates, stored in the Tuberculosis Unit of the Microbiology Laboratory at Gaziantep University Hospital and obtained from clinical samples of patients, were included in the study. These isolates, previously typed using Xpert Ultra PCR and culture/antigen testing and sent to the Turkish Ministry of Health Public Health Institution (THSK) Microbiology Reference Laboratory for phenotypic testing and second-stage drug resistance profile reporting, were revived from the cold archive and included in the study. The isolates were cultured again in MGIT 960 liquid-based, fully automated, growth-controlled culture tubes.500 microliters of bacterial suspension grown in an MGIT tube were transferred to cartridges of the Xpert MTB/XDR system, and resistance genes to isoniazid, fluoroquinolone, amikacin, kanamycin, and capreomycin were analyzed. Our Expert MTB/XDR test results were compared with the phenotypic (MGIT 960) anti-TB drug resistance results reported by the Turkish Ministry of Health. The level of agreement/consistency between the obtained test results was investigated using Cohen's Kappa test.

After determining antituberculosis drug resistance using genotypic and phenotypic tests, the Kappa Test was applied, and the diagnostic performance of phenotypic methods and the Expert MTB/XDR test was compared. The phenotypic methods and the Expert MTB/XDR test showed 100% agreement with fluoroquinolone, capreomycin, and amikacin resistance, while both tests showed 83.3% agreement with isoniazid resistance. For kanamycin resistance, the tests showed 80% agreement. Statistical analyses were performed, and Cohen's Kappa coefficient was calculated, yielding a value of 0.571 for isoniazid.

In conclusion, while moderate agreement was reported for Isoniazid and low agreement for Kanamycin in phenotypic and genotypic test results, complete agreement was found between genotypic and phenotypic tests in evaluable samples for Fluoroquinolones, Amikacin, and Capreomycin. The complete agreement in evaluable isolates in the Amikacin, Capreomycin, and Fluoroquinolone groups supports the high consistency of genotypic tests with phenotypic DST in these drugs.

Keywords: Tuberculosis, Expert MTB/XDR, antimicrobial resistance.

*This study encompasses Ahmet Selman MIZRAKLIDAĞ's postgraduate thesis work at Gaziantep University, Institute of Health Sciences, Department of Medical Microbiology, under the supervision of Assoc. Prof. Dr. Deniz GAZEL.

DEVELOPMENT OF AN ALGINATE-BASED BIOMATERIAL WITH ANTIBACTERIAL PROPERTIES

Erdem Bağseven

Department of Chemistry, Faculty of Science, Izmir Institute of Technology

Izmir, Türkiye

ORCID: 0009-0003-9484-5812

Nermin Seda Kehr

Department of Chemistry, Faculty of Science, Izmir Institute of Technology

Izmir, Türkiye

ORCID: 0000-0003-2275-1254

ABSTRACT

Chronic wounds are defined by their inability to complete the sequential process of tissue healing, typically remaining unclosed for an extended period, often exceeding several weeks. Over recent decades, these wounds have emerged as a major clinical challenge due to their increasing prevalence and the heightened recognition of their profound implications for patient health, quality of life, and healthcare systems. A critical factor contributing to their persistence and recurrence is tissue hypoxia, which impairs cellular proliferation, angiogenesis, and collagen synthesis processes essential for effective wound repair. The wound-healing process can be promoted and accelerated through the application of advanced biomaterials, effective antibacterial agents, and bioactive essential oils. In addition, hydrogels represent a modern and highly effective class of biomaterials for wound healing. Hydrogels are three-dimensional porous networks composed of polymer chains interconnected through physical or chemical crosslinks. They have been widely explored as promising materials for antibacterial applications. Through the strategic selection of monomers and crosslinking agents, key characteristics such as hydrophilicity and porosity can be precisely tailored to enhance their antibacterial performance. In addition, certain hydrogel systems possess intrinsic antibacterial properties with adding essential oils, further expanding their potential in biomedical use.

Essential oils from aromatic and medicinal plants possess notable antioxidant and broad-spectrum antimicrobial activities. Their biological properties make them valuable natural agents for limiting bacterial resistance. To counteract the chronic oxidative stress and cellular impairment resulting from hypoxia, the incorporation of powerful antioxidant agents is necessary.

The aim of this study is to develop an alginate-based biomaterial treated with essential oil and to investigate its effects on chronic wound healing as well as its antibacterial properties. The primary focus of this study is to evaluate the effects of the developed biomaterial on chronic wound healing, particularly its potential to promote or accelerate tissue repair. Additionally, the biomaterial's ability to inhibit the proliferation of both Gram-positive and Gram-negative bacteria, along with its bactericidal activity, was comprehensively determined.

Keywords: wound-healing process, bioactive essential oils, alginate-based biomaterial, antibacterial properties

DESIGN AND DEVELOPMENT OF A SYRINGE PUMP SYSTEM FOR BIOMEDICAL MICROROBOT APPLICATIONS

Kadri Emre Orgun

Graduate School of Natural and Applied Sciences, Department of Robotics Engineering, İzmir Katip Çelebi University

Çiğli, İzmir, Türkiye

ORCID: 0009-0006-9473-9317

Levent Çetin

Department of Mechatronics Engineering, İzmir Katip Çelebi University

Çiğli, İzmir, Türkiye

ORCID: 0000-0002-7041-0529

Mehmet Ersü

Department of Mechatronics Engineering, İzmir Katip Çelebi University

Çiğli, İzmir, Türkiye

ORCID: 0009-0003-5390-1638

Serkan Doğanay

Department of Mechatronics Engineering, İzmir Katip Çelebi University

Çiğli, İzmir, Türkiye

ORCID: 0000-0002-3237-693X

ABSTRACT

In recent years, biomedical microrobots have shown great promise for future minimally invasive treatments. They specifically aim to enable approaches like delivering drugs directly to hard-to-reach tissues with minimal damage. However, before these technologies can be used in real applications, we must fully understand how they behave within the complex structure of the human circulatory system. Navigating inside blood vessels is highly difficult not only due to complex vascular pathways but critically because of the pulsatile nature of blood flow driven by the heartbeat. Also, the natural elasticity of vascular walls affects flow behavior, making the motion control of microrobots challenging. Because of these real-world complexities, before moving to in vivo studies, we need to build reliable in vitro setups that can truly replicate these tough physiological conditions.

Syringe pumps used in microfluidic studies are usually built to provide a constant flow rate. However, generating variable flow rates presents mechanical challenges. Factors like backlash between mechanical parts, delays caused by frictional resistance during initial movement, and the elasticity of the tubing used lead to irregularities in fluid flow. Because of these limitations, standard syringe pumps struggle to produce the responsive wavy flows needed for realistic testing. This study aims to solve this problem by developing a custom syringe pump designed to simulate these dynamic flows. The proposed system achieves flow rates between 0.1 mL/s and 10 mL/s.

The mechanical setup of the developed syringe pump system is driven by a stepper motor controlled by a stepper motor driver configured to ensure precise actuation. A silicone channel is used in the flow line to represent vascular elasticity. The main challenge in the project is to overcome flow errors caused by standard mechanical components. For this purpose, an integrated control strategy has been developed. We integrated a standard load cell that constantly measures the total weight of the fluid pushed out in real-time. Using total weight change gives a stable feedback signal that shows the actual fluid delivery. This approach is also more accessible compared to expensive flow sensors. By calculating the change in this mass data over time, the instantaneous flow rate is derived. This allows adjusting the motor speed to correct errors caused by mechanical flaws and helps the system to follow the targeted pulsatile flow profiles.

Keywords: Biomedical microrobotics, physiological flow simulation, syringe pump, load cell, flow rate control

CLINICAL SUPERIORITY AND MULTIMODAL APPLICATIONS OF CNT/PDMS-BASED FLEXIBLE PIEZORESISTIVE SENSORS

Fatma Bayrakci

Biomedical Technologies, Dokuz Eylul University

İzmir, Buca, Türkiye

ORCID: 0009-0007-6942-2809

Özge Cihanbeğendi

Electrical Electronics Engineering, Dokuz Eylul University

İzmir, Buca, Türkiye

ORCID: 0000-0001-7839-2954

ABSTRACT

Thanks to rapid technological advancements and the new structures brought about by digitalization, biomedical engineering has undergone an ergonomic shift from rigid, bulky devices to flexible, human-integrated systems. Therefore, the development of materials that can integrate almost seamlessly with human physiology is vital. Among these new technologies, carbon nanotube (CNT) and polydimethylsiloxane (PDMS)-based piezoresistive sensors offer solutions similar to traditional medical monitoring devices. This study explores and explains the versatile advantages of CNT/PDMS-based piezoresistive sensors and their critical importance in non-invasive diagnosis, continuous health monitoring, and smart implantable systems. For example, while traditional blood pressure cuffs provide instantaneous measurements, CNT/PDMS sensors offer continuous, cuff-free monitoring. High-sensitivity sensors placed on the wrist enable detailed analysis of arterial pulses and provide information on arterial stiffness. Passive CNT/PDMS sensors integrated into stents or aneurysm grafts can also be used for early diagnosis of postoperative complications by wirelessly transmitting intravascular pressure and flow rate. Due to their high conductivity, CNTs can be utilized as dry electrodes. Therefore, CNT/PDMS electrodes can make excellent skin contact without the use of gel, allowing for the recording of cardiac (ECG) and brain (EEG) signals without compromising signal quality or causing skin irritation. Another example is the use of flexible CNT/PDMS implants in spinal cord injuries. Unlike rigid metal electrodes, they can stimulate neuronal activity without causing mechanical damage to nerve tissue. Furthermore, smart bandages can simultaneously monitor temperature increases and pressure changes caused by swelling for chronic wound monitoring. They can even provide controlled drug release when an infection is detected. CNT/PDMS composites, which prevent bacterial biofilm formation by changing the surface energy of the nanotubes, significantly reduce bacterial adhesion compared to pure polymers. This ensures the sensor's safe use inside and outside the body. Human tissues are soft and flexible, while metals are hard. Because CNT/PDMS-based sensors can flex with the skin or organs, they do not cause discomfort to the patient and prevent tissue damage, such as inflammation caused by mechanical disharmony. Another problem is that wearable devices can be damaged during daily movements, increasing costs for the user. However, new-generation CNT/PDMS sensors, which incorporate dynamic covalent bonds within their structures, can self-heal with 97.8% efficiency even when cut at room temperature.

This study presents the significance, development, advantages, and clinical applications of CNT/PDMS-based piezoresistive sensors, emphasizing their growing role in future biomedical systems.

Keywords: Carbon nanotubes (CNTs), Polydimethylsiloxane (PDMS), Piezoresistive, Biosensors

SCREEN-PRINTED ELECTRODES IN MODERN ELECTROCHEMICAL BIOSENSING: MATERIALS, MODIFICATIONS, APPLICATIONS, AND FUTURE DIRECTIONS

Hezzal Küçükselbes

Research and Development Department, AGON Biotechnology Industry and Trade Ltd. Co.

Izmir, Türkiye

ORCID: 0009-0006-0451-1045

Özge Cihanbeğendi

Department of Electrical and Electronics Engineering, Dokuz Eylül University

Izmir, Türkiye

ORCID: 0000-0001-7839-2954

ABSTRACT

Screen-printed electrodes (SPEs) have become widely used electrochemical platforms due to their low cost, reproducibility, and suitability for large-scale, decentralized analytical systems. Their flexibility in substrate choice, ink composition, and electrode geometry enables precise control of electrochemical behavior, making them highly valuable for modern biosensing. As disposable, portable, and miniaturized sensors, SPEs offer a strong alternative to traditional three-electrode setups in chemical, environmental, and biomedical applications. This review summarizes recent progress in SPE materials, fabrication approaches, surface modifications, and emerging applications, while highlighting current challenges and future research needs. Significant advances in nanomaterial integration—including carbon nanotubes, graphene, MXenes, metal oxides, noble metal nanostructures, and conductive polymers—have improved electron-transfer kinetics, catalytic activity, and active surface area. Functional nanocomposites such as CNT–metal oxide hybrids, graphene–polymer films, and nanoparticle-modified carbon inks have enabled highly sensitive detection of diverse biomolecules, including neurotransmitters, metabolites, pathogens, nucleic acids, and cancer-related targets. In parallel, biorecognition elements such as enzymes, antibodies, aptamers, redox mediators, and molecularly imprinted polymers have enhanced selectivity, solidifying SPEs as a key technology in biosensor design. SPE platforms are increasingly integrated into portable and point-of-care systems through smartphone interfaces, microfluidics, wearable electronics, and wireless data acquisition. These advancements support rapid monitoring of infectious diseases, mental health markers, hormones, food contaminants, environmental pollutants, and agricultural analytes. Multiplexed SPE arrays and microfluidic combinations further enable simultaneous multi-analyte measurement, improving diagnostic efficiency. Despite rapid progress, limitations remain, including ink variability between production batches, limited long-term stability of modified surfaces, biofouling in complex samples, and the absence of standardized calibration practices. Future development is expected to focus on AI-assisted electrochemical data processing, sustainable electrode materials, roll-to-roll manufacturing, flexible and stretchable architectures, and advanced nanocomposites capable of ultra-trace biomarker detection. Overall, SPEs constitute a versatile and powerful sensing platform with significant potential in clinical diagnostics, environmental monitoring, food safety, and personalized medicine. Their modular design, low manufacturing cost, and compatibility with emerging digital technologies position them to play a central role in the next generation of electrochemical biosensing.

Keywords: Screen-printed electrodes, electrochemical biosensor, point-of-care diagnostics

A PORTABLE SCREEN-PRINTED ELECTRODE SYSTEM FOR ULTRA-SENSITIVE SALIVARY SEROTONIN DETECTION

Aleyna Yıldız
Department of Molecular Medicine, Graduate School of Health Sciences, Dokuz Eylül University
Izmir, Türkiye
ORCID: 0000-0003-1111-7303

Fulya Yoldaş
Department of Molecular Medicine, Graduate School of Health Sciences, Dokuz Eylül University
Izmir, Türkiye
ORCID: 0000-0002-9666-1414

Hezzal Küçükselbes
Department of Electrical and Electronics Engineering, Dokuz Eylül University
Izmir, Türkiye
ORCID: 0009-0006-0451-1045

Arda Yılmaz
Research and Development Department, AGON Biotechnology Industry and Trade Ltd. Co.
Izmir, Türkiye
ORCID: 0009-0009-8538-8676

Dilde Duru
Department of Bioengineering, Manisa Celal Bayar University
Izmir, Türkiye
ORCID: 0009-0001-4664-7032

Özge Cihanbeğendi
Department of Electrical and Electronics Engineering, Dokuz Eylül University
Izmir, Türkiye
ORCID: 0000-0001-7839-2954

ABSTRACT

Serotonin (5-hydroxytryptamine, 5-HT) is a key neuromodulator involved in mood regulation, stress response, sleep, and metabolic pathways. Rapid, cost-effective, and minimally invasive measurement of serotonin levels is essential for both clinical screening and point-of-care monitoring. An electrochemical detection platform was developed and validated using disposable screen-printed electrodes (SPEs), which are widely adopted for neurotransmitter sensing due to their high sensitivity, portability, and low-cost fabrication.

The measurement workflow was optimized using a dedicated protocol interface enabling multi-step amperometry, calibration, and standardized test configuration. Saliva samples (50 µL) were directly applied onto the electrode surface following the established protocol. The resulting oxidation signals produced clear, stable, and reproducible electrochemical responses consistent with the known voltammetric behavior of serotonin on carbon-based SPEs.

Experimental trials demonstrated strong concentration-dependent electrochemical signals across a physiologically relevant range. Clinical pilot measurements revealed salivary serotonin concentrations between approximately 10–80 µM, aligning with biological variability influenced by age, hormonal fluctuations, stress levels, dietary factors, and medication use. Individuals using selective serotonin reuptake inhibitors exhibited elevated serotonin signatures, while asthmatic subjects demonstrated peripheral serotonin elevations associated with inflammatory mechanisms. Conversely, individuals under thyroid hormone treatment showed comparatively lower serotonin-related electrochemical responses, consistent with known interactions between thyroid regulation and serotonergic pathways.

The SPE configuration provided highly consistent and repeatable signals, supporting its suitability for disposable, contamination-free measurements. The portable reader allowed real-time visualization of amperometric and voltammetric curves, automatic concentration calculation, and seamless user operation, aligning with the capabilities of modern smartphone-integrated electrochemical sensing technologies.

Overall, the results demonstrate that the developed SPE-based platform is a reliable, accessible, and high-throughput method for quantifying serotonin in saliva. Its strong analytical performance within clinically meaningful concentration ranges, combined with portability, ease of use, and minimal sample volume requirements, positions it as a promising candidate for point-of-care diagnostics, mental health monitoring, and large-scale clinical research. Future work will focus on expanding calibration datasets, integrating machine-learning–based signal processing, and validating the platform against standard laboratory techniques across broader patient groups.

Keywords: Serotonin, Screen-printed electrodes, electrochemical biosensor, multi-step amperometry

SYNTHETIC EEG SIGNAL GENERATION AND NOISE INTEGRATION: VALIDATION THROUGH MATHEMATICAL MODELING

Elif Nur Selçuk

Department of Mechanical Engineering, Graduate School of Natural and Applied Sciences,

Suleyman Demirel University, Isparta, Türkiye

ORCID: 0000-0003-3799-4304

Mustafa Reşit Usal

Department of Mechanical Engineering, Faculty of Engineering and Natural Sciences

Suleyman Demirel University, Isparta, Türkiye

ORCID: 0000-0003-1823-4879

Hatice Akman

Department of Biomedical Engineering, Faculty of Technology,

Isparta University of Applied Science, Isparta, Türkiye

ORCID: 0000-0002-1416-2057

Gökçenur Çakmak

Department of Mechanical Engineering, Graduate School of Natural and Applied Sciences,

Suleyman Demirel University, Isparta, Türkiye

ORCID: 0000-0002-3315-4714

ABSTRACT

Electroencephalography (EEG) is a key neurophysiological measurement method used for diagnosing neurological disorders, investigating cognitive processes, and developing brain–computer interface (BCI) systems. EEG signals show very low amplitudes in the microvolt range, rendering them very sensitive to many biological and environmental aberrations, including eye movements (EOG), muscle activity (EMG), and power line interference. These aberrations substantially impair signal quality, elevate the likelihood of diagnostic inaccuracies in clinical applications, and diminish BCI efficacy.

Assessing the efficacy of algorithms intended to eliminate artifacts from EEG signals is particularly difficult. Artificial signals often employed for testing inadequately represent the intricacies of authentic human EEG. An optimal test model must concurrently include the brain's intrinsic activity, electrode-associated effects, and diverse noise sources in a realistic fashion. The lack of a comprehensive and integrated model hinders reliable assessment of development in the field. The principal objective of this study is to fill this vacuum in the literature by establishing a dependable framework for the validation of EEG data collecting devices and the assessment of noise suppression methods. An integrated EEG generation system has been designed to produce multi-component clean EEG encompassing delta, theta, alpha, and beta bands; accurately simulate EOG, EMG, and power line noise; and consider electrode-skin impedance interactions. The model is augmented with pink noise and biological modulations, facilitating the generation of synthetic signals that closely mimic authentic EEG records.

The RMS (Root Mean Square) value is a crucial statistical metric that measures the average amplitude of a signal and is extensively utilized to assess the power characteristics of EEG components. The quantitative evaluations conducted on the model's outputs confirm its efficacy. The clean EEG signal was recorded at 29.1 µV RMS, whilst the EOG and EMG components were measured at 50.1 µV and 21.3 µV RMS, respectively. The signal-to-noise ratio (SNR) of the noise-augmented signal was computed at 13.03 dB, subsequently diminishing to 5.32 dB following the application of notch and band-pass filters. The strong correlation coefficient of 0.852 between the filtered and reference signals, coupled with the low mean absolute error (MAE) ranging from 5.49 to 12.96 µV, indicates that the model effectively reproduces authentic EEG morphology. The findings suggest that the suggested model possesses significant potential to offer a standardized, controlled, and realistic testing environment for the development of EEG-based systems and algorithms. Moreover, the model functions as a crucial tool for producing labeled and scalable synthetic data, especially for neural network classifiers, thereby making a substantial contribution to mitigating data scarcity in the domain.

Funding: This study was supported by the Scientific Research Projects Coordination Unit (BAP) of Süleyman Demirel University (Project No: FDK-2022-8789).

Keywords: Noise modeling, EEG, signal simulation, EOG, EMG

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