AdımODTÜ
UNDERGRADUATE
RESEARCH
PROJECT 2025

Examples of Undergraduate Research Projects supported by AdımODTÜ in 2025

70 years
METU

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ODTÜ
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dünyayı
değiştirebiliriz

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A joint project of the Office of Communications and METU Development Foundation, AdımODTÜ is a communication-sharing-action platform where everyone can provide financial support to the scientific research and community service projects of our students and faculty members, contribute to the announcement of the projects and even take part in projects on a voluntary basis.

Research at METU starts in undergraduate years!

AdımODTÜ has created a fund to support the research efforts of undergraduate students through donations. In this booklet, examples of undergraduate projects that have applied to AdımODTÜ are presented. These projects are either fully or partially supported by AdımODTÜ.

SENSEMED

Research Area: Visually Impaired People

Project Team Members: Berrak Keçeli, Doğa Bilgen, Meryem Yünkül and Nihal Mente

Project Supervisors: Prof. Bahar Şener-Pedgley

Abstract:

SENSEMED is a medication guide kit that eliminates the difficulties experienced by visually impaired individuals in taking medications and aims to improve their quality of life. Users can access medication names, dosage information, and instructions by clicking the textured labels on medication packaging and matching them with the corresponding buttons on the device. This system allows elderly and visually impaired individuals, especially those taking multiple medications (polypharmacy), to manage their medications independently and safely without needing to know Braille.

The Impact of Familiarity and Handedness on Grasping Affordance

Research Area: Visual Perception, Affordances, Experimental Psychology

Project Team Members: Alper Artan

Project Supervisors: Assoc.Prof. Dicle Nahide Dövencioğlu

Abstract:

Affordances refer to the action possibilities provided to an animal by the qualities of an environment. While the influence of handle orientation on affordances of grasping (as implicit measures of motor affordances) has been widely studied, the influence of familiarity on grasping affordances remains understudied. Moreover, while most affordance studies used only or almost exclusively right-handed participants, there are very few studies that also consider left-handed individuals. To fill these gaps in the literature, the current study investigated the influence of tool familiarity, tool handle orientation, and handedness. In a laboratory environment, 20 left-handed and 20 right-handed participants completed a grasping affordance judgment task. Their reaction time (RT) and proportion correct (PC) data showed that people are differentially influenced by handle orientation depending on their handedness.

Electronic Warfare Device Against FPV Drones

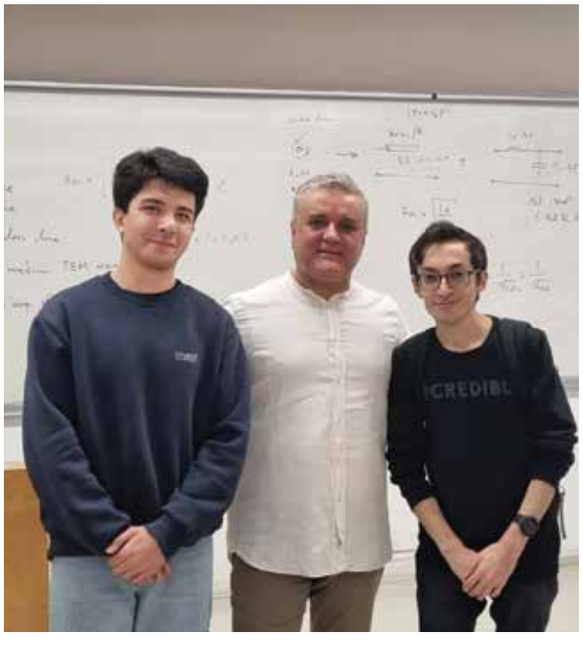
Research Area: Electromagnetics, RF, Electronic Warfare

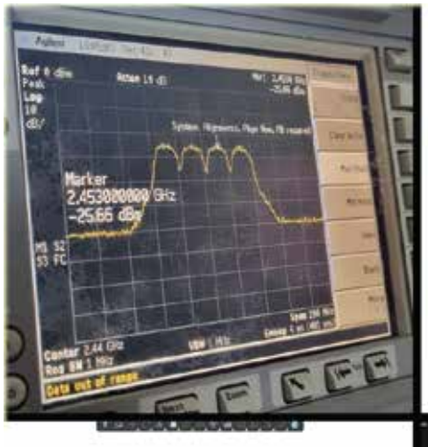
Project Team Members: Tuğrul Çağrı Alper and Lezgin Alimoğlu

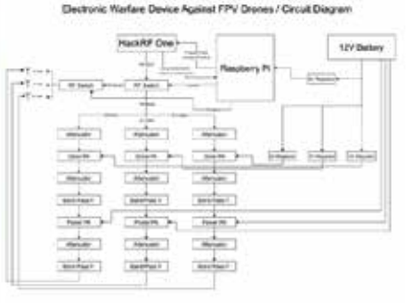
Project Supervisors: Prof. Şimşek Demir

Abstract:

In our project, we aimed to develop an electronic warfare product that is more open-source, accessible, and low-cost than existing products on the market, in response to the threat posed by FPV drones, one of the newest elements of the rapidly changing battlefields. The product, for which we are about to produce the first prototype, is based on SDR (Software-Defined Radio), and target detection and jamming processes are carried out through this device. Low-power outputs are increased to the targeted 1-1.5 Watts with our custom RF amplifier circuit board. While not effective for very large areas, it provides a life-saving jamming capability for team-sized units. In later stages of the project, we aim to produce high-gain antennas and achieve higher-power jamming capability with a multi-stage amplifier.







$CsPbBr_3$ Perovskite Nanocrystal Scintillators for High-Resolution Medical Imaging

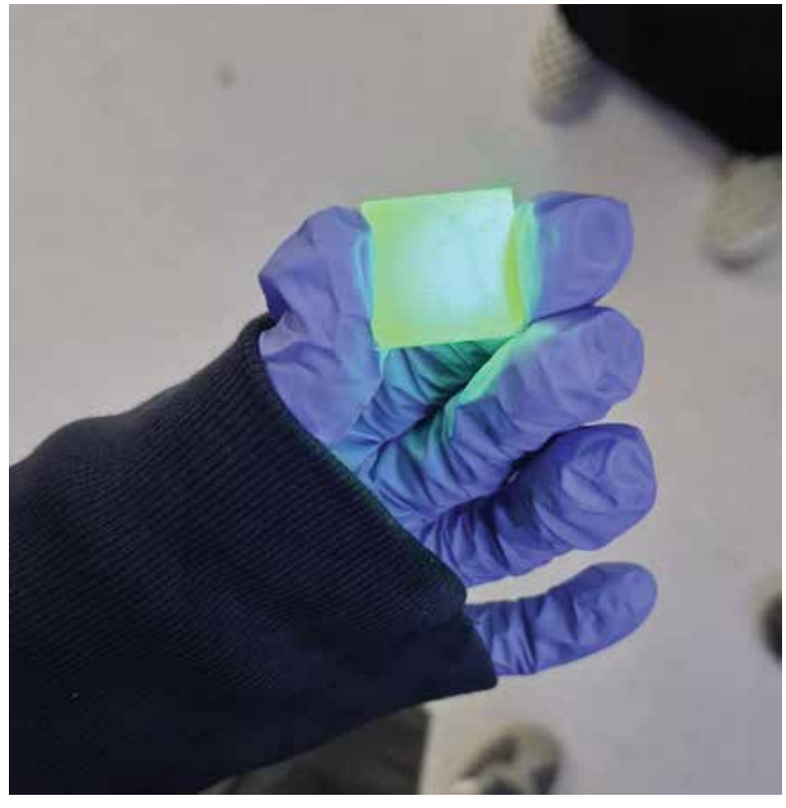
Research Area: Materials Science, Nanotechnology, Medical Imaging

Project Team Members: İlayda Ayyıldız, Ayşenur İrfanoğlu, Ebru Karayel, Umut Tutal, Öykü Yurdakul, Özge Yurdakul and Zeynep Ilgın Yüceer

Project Supervisors: Assist. Prof. Yusuf Keleştemur, Prof. Hüsnü Emrah Ünalan and Prof. Cemil Hakan Gür

Abstract:

Medical X-ray imaging uses scintillators to convert radiation into visible light, but standard materials often require higher doses to achieve clear images, increasing patient risk. Our project addresses this by developing a nanocrystal-based scintillator using lecithin-capped $CsPbBr_3$ perovskite nanocrystals in a polystyrene matrix, offering higher light yield, faster decay, and better dispersion while reducing lead toxicity. Thin films produced with this material showed clearer images at lower X-ray exposures, outperforming conventional bulk scintillators. A financial review indicates commercial viability, with break-even achievable after selling about 110 units annually. This is the first demonstration of these nanocrystal films for high-resolution X-ray imaging at reduced doses, highlighting their potential to improve patient safety in diagnostics.



Development and Application of an Ultrasonic Printing-Based Method for the Production of Metal Layers with Controllable Surface Quality

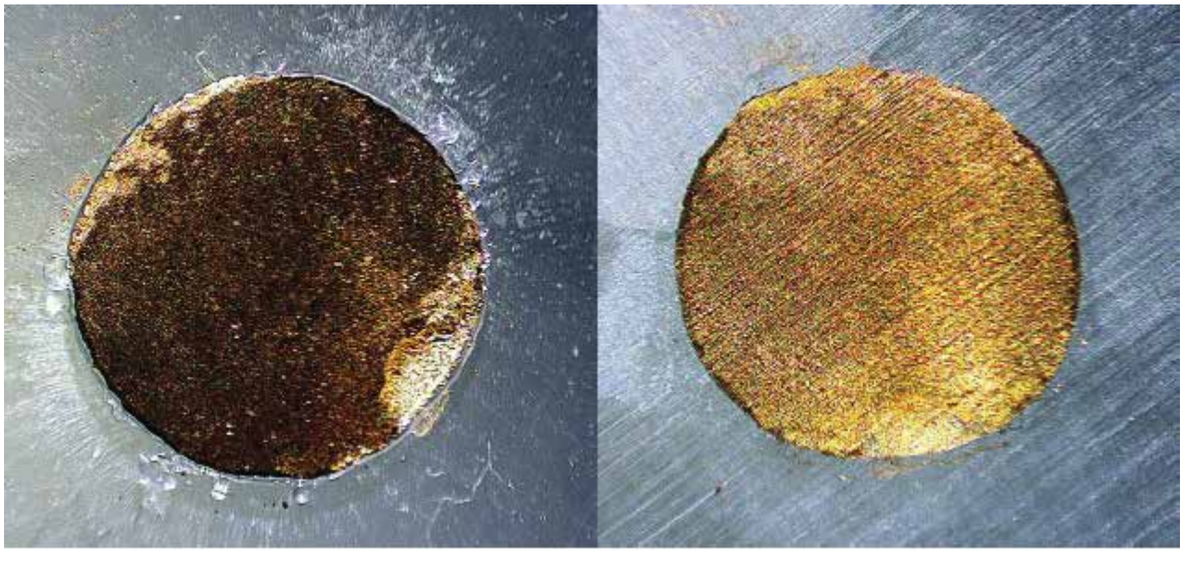
Research Area: Micromanufacturing

Project Team Members: Arif Miran Karabel

Project Supervisors: Assoc.Prof. Ender Yıldırım

Abstract:

A rapid ultrasonic sintering method was used to fabricate gold films on PMMA substrates for low-cost metal patterning. Conductivity was measured with a custom four-point probe system, and film thickness was evaluated through cross-sectional microscopy. As-sintered films showed low electrical performance due to insufficient particle coalescence. To improve this, force-assisted annealing at sub-Tg temperatures was applied, which enhanced particle connectivity and significantly reduced resistance without deforming the substrate. The results show that controlled low-temperature annealing is an effective way to improve the structural quality and electrical properties of ultrasonically sintered metal films, enabling their use in electrochemical and biosensing applications.



Perceived Gender Stereotypes of Students in Engineering Programs Scale

Research Area: Psychology

Project Team Members: Elif Aktaş, Doğa Nalçacıoğlu, Nazlı Hilal Sarıavcı, Sümeyye Gökçe Yalçın, Zeynep Neva Şeker

Project Supervisors: Assoc.Prof. Yonca Toker Gültaş

Abstract:

Generalized and oversimplified beliefs about men and women are considered as gender stereotypes (Kovaleva et al., 2022). Gender stereotypes criticize women's place in society, and these stereotypes can be concentrated around science, technology, engineering, and math (i.e., STEM) fields (Dersch et al., 2022). In Türkiye, Kadayıfçı (2017) highlighted that the perception of the engineering occupation could be a "man's job". The goal of the current study was to develop a tool for assessing how much Turkish engineering students perceive gender stereotypes. The research consists of two studies. The first study with 200 Turkish engineering students was done to determine the factors and reliability of the items we developed. In the second study, a new sample that consisted of 250 Turkish engineering students was enrolled to assess the scale's validity by investigating the relationship between the PGSSEPS and the PSGBI, ambivalent sexism, general self-efficacy, academic domain satisfaction, and STEM continuation intentions.

METU ANZU UAV
Autonomous Fixed-Wing Combat UAV

Research Area: Autonomous Unmanned Aerial Vehicles (UAVs), Autonomous Flight Systems, Combat UAV Technologies, Guidance, Navigation and Control (GNC), Vision-Based Target Detection

Project Team Members: Umut Barış Genç, Mustafa Said Sulak, Mehmet Ali Akıncı and Deniz Baran (Electronics), Bedri Anıl Gedikli, Selahattin Kağan Doğaner, Yusuf Yanık, Eren Okur, Zeynep Ece Yılmaz and Öykü Özçiçek (Mechanics), Ege Mert Balçık, Mehmet Alp Özaydın, Hüseyin Umut Işık, Hüseyin Kerem Aktaş, Eren Aslan, Efe Kaan Güler and Ela Naz Alak (Software), Ahmet Rıza Filiz and Kürşat Ergün (Organization)

Project Supervisors: Assoc.Prof. Şeyda Ertekin Bolelli

Abstract:

This project presents the development of an autonomous fixed-wing Unmanned Aerial Vehicle (UAV) designed for the TEKNOFEST Combat UAV Competition. The primary objective is to enable fully autonomous mission execution, including environment perception, opponent UAV detection, and decision-making without human intervention. The system integrates flight control, mission planning, communication, and vision-based target detection subsystems. Aerodynamic design and stability analyses were conducted using XFLR5, while propulsion optimization was performed with MotoCalc. Lightweight foam structures reinforced with carbon fiber spars were used to achieve an optimal balance between durability and weight. The UAV demonstrated high maneuverability and stable autonomous flight during field tests. This project provides hands-on experience in autonomous UAV system integration and contributes to the advancement of next-generation combat UAV technologies.

From Waste to Value: Optimization of Leaching Process for Precipitated $CaCO_3$ Production from Blast Furnace Slag

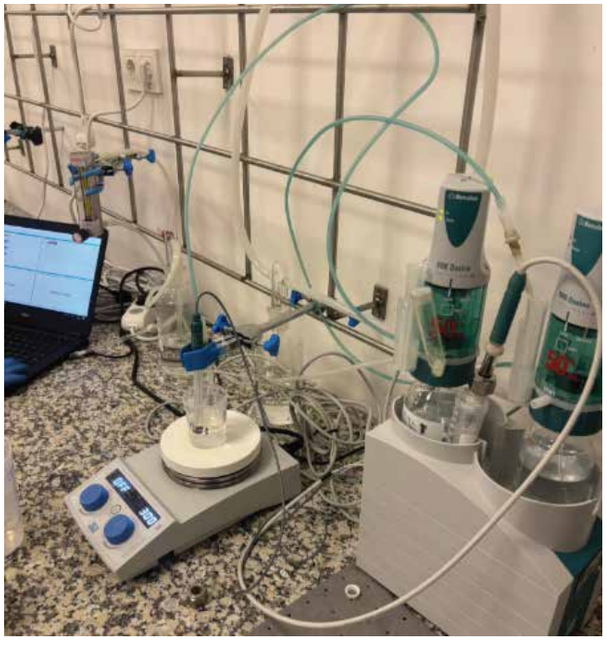
Research Area: Sustainable Resource Recovery Technologies, Guidance, Navigation and Control (GNC), Vision-Based Target Detection

Project Team Members: Su Karaoğlu and Kaan Yetiş

Project Supervisors: Assist.Prof. Şeniz Uçar and Cansel Mehmetalioğlu

Abstract:

With hundreds of kilograms of slag generated per ton of steel, Türkiye produces millions of tons annually, creating a major industrial waste challenge. Blast furnace slag, a byproduct of steel production, is an alkali waste with high calcium content along with silica, and lower amounts of Mg, Fe, and other elements. This study focuses on developing an efficient leaching method to recover high-purity calcium from blast furnace slag for the synthesis of precipitated calcium carbonate (PCC), an FDA-approved compound widely used as a filler in paper, paint, and construction materials. The process optimization using 0.5 M HCl for 1 hour leaching achieved a calcium extraction efficiency of 87%, which was confirmed through EDTA titration and ICP-OES analyses. The recovered calcium was used for the synthesis of aragonite-type PCC, demonstrating the potential of this approach for sustainable resource recovery, reducing industrial waste, and producing a value-added material.



High-Entropy Sulfides as Cathode Catalysts for Zinc-Air Batteries

Research Area: Electrochemistry, Battery

Project Team Members: Nazlıcan Uysal and Zeynep Ilgın Yüceer

Project Supervisors: Assist.Prof. Çiğdem Toparlı

Abstract:

This study introduces pyrite-type high-entropy sulfides (HESs) as robust bifunctional air cathodes for rechargeable zinc-air batteries (ZABs). Three single-phase compositions were synthesized via mechanochemistry, with HES-TM [(FeNiCoCrMn)S2] exhibiting superior performance over other variants. HES-TM demonstrated a narrow bifunctional voltage gap of 0.94 V and exceptional stability, driven by optimized metal-sulfur coordination and mixed-valence surface states. When integrated into a full ZAB cell, the catalyst delivered a peak power density of 88 mW cm ^{2}, a high specific capacity of 675.9 mAh, and maintained stable operation for over 25 days. These findings establish disorder-engineered sulfides as cost-effective, scalable alternatives to noble metals, offering significant potential for next-generation energy storage applications.

Sustainability in Higher Education: A Comparative Institutional Analysis of the METU and University of Twente

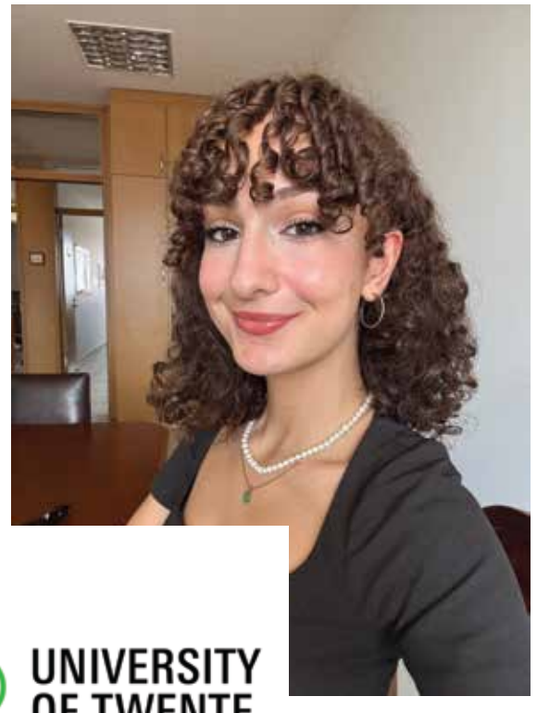
Research Area: Campus Sustainability, Governance Structures, Policy Making and Implementation, SDGs

Project Team Members: Eylül Mavzer

Project Supervisors: Assoc.Prof. Asuman Göksel

Abstract:

This study conducts a comparative institutional analysis of the Middle East Technical University (METU, Türkiye) and the University of Twente (UT, Netherlands) to evaluate the efficiency of their sustainability policies. Focusing on the environmental dimension of the Sustainable Development Goals (SDGs), the research investigates how different institutional governance structures—centralized versus participatory—influence policy implementation and effectiveness. Qualitative data, derived from five semi-structured interviews with key stakeholders and secondary policy documents, were analyzed using thematic analysis. The findings consistently show that UT's participatory network governance model (via the SEE Programme and Green Hub) is significantly more adaptive and resilient than METU's centralized linear model. This highlights that moving the locus of control from a single authority to an integrated stakeholder network is critical for converting visionary goals into sustainable campus realities.



METU

UNIVERSITY OF TWENTE.

Design and Development of a Mechanical Filtration Payload for Small Satellite Systems for Teknofest

Research Area: Satellite Competition

Project Team Members: Feyza Eryılmaz, Alp Eren Özgün , Zeynep Ece Yılmaz, Eylül Muslubaş , Zehra Eda Uğuz and Ali Gökçe

Project Supervisors: Assist. Prof. Görkem Eğemen Güloğlu

Abstract:

This research presents the preliminary design of a Category-1 model satellite developed by the METUOR Türksat team for the 2025 TÜRKSAT Model Satellite Competition. The project focuses on creating a dual-component system consisting of a container and a payload capable of autonomous separation at an altitude of 400 meters. The system integrates advanced sensors (BMP388, BNO055, NEO-M8N) and an STM32-based flight computer to process real-time telemetry data. A key innovation of the design is the mechanical multispectral filtering module, controlled by dual servo motors to enable dynamic image acquisition. Structural integrity is ensured through lightweight 3D-printed LW-PLA components and comprehensive environmental test planning, including vibration and thermal analyses. Preliminary results confirm that the calculated descent rates of 12–14 m/s for the container and 6–8 m/s for the payload satisfy the competition requirements for safe landing.

Feyza Eryılmaz

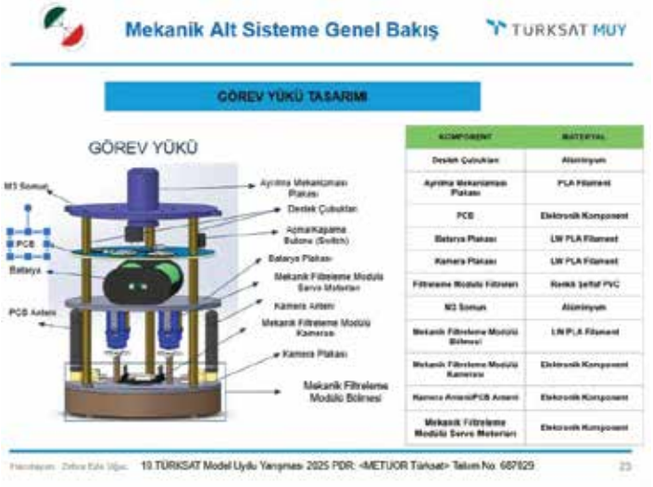
Alp Eren Özgün

Zeynep Ece Yılmaz

Eylül Muslubaş

Zehra Eda Uğuz

Ali Gökçe

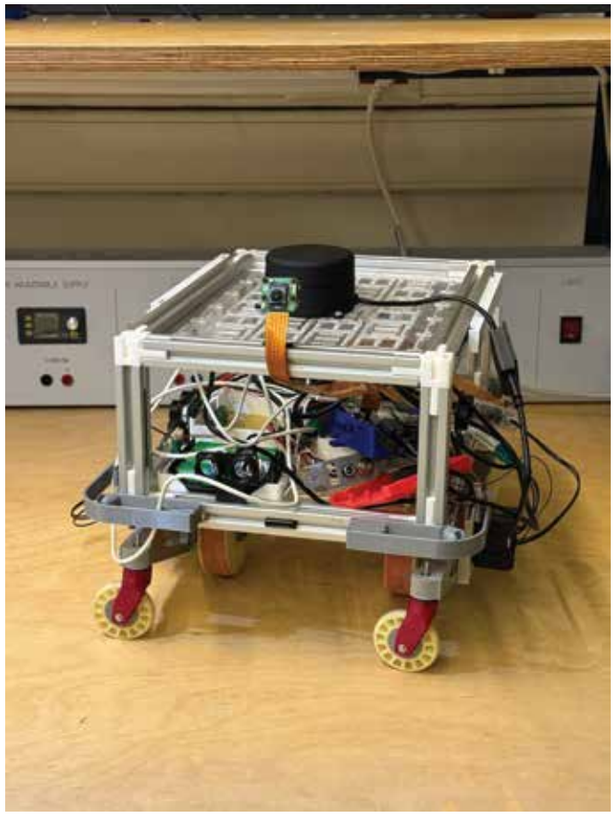


Altay Hattı: Scalable Target Tracking System: Midibot Example

Research Area: Robotics and Autonomous Systems
Project Team Members: Eyup Kağan Şahin, Tevfik Batuhan Odman and Serhan Turhan
Project Supervisors: Assoc.Prof. Ahmet Buğra Koku

Abstract:

Target tracking algorithms hold a critical role in many industries such as automotive, manufacturing and national defense, especially for autonomous systems of products. This study aims to create and validate a compact and scalable target identification and tracking algorithm as a part of Altay Hattı project. For this purpose, the infrastructure of MidiBot, which is a previously designed robotic platform created by METU ROMER, has been improved and by the integration of LiDAR and image processing technologies, it has been converted to a hybrid target following platform. In this study, the location and image information that have been obtained through the processing of sensor data was tested on a moving robotic platform, MidiBot. This study reveals that instead of the large-scale algorithms that are used in defense and security systems, which are expensive, closed-source and problem-specific; open-source algorithms can provide satisfying results on a compact platform in a controlled laboratory environment, also indicating that this algorithm can be tested in different conditions with correct modifications and integrations, validating itself as a scalable and modular R&D test algorithm alternative.



The Role of Women's Labor in the Rural Development Process in Ankara: The Case of Women's Cooperatives

Research Area: Rural Development, Gender Studies
Project Team Members: Aslı Ceylan, Mehmet Enes Deligöz and Muhammed Can Torun
Project Supervisors: Prof. Aylin Topal

Abstract:

This research analyzes the transformative role of women's cooperatives. In the rural development processes of Ankara, with a specific focus on the economic, social, and political dimensions of women's labor. The primary aim is to examine how cooperative structures facilitate economic inclusion, market integration, and social empowerment for women in rural areas. The methodology adopts a qualitative, multi-stakeholder approach, utilizing semi-structured interviews to investigate the interactions between women's cooperatives and key actors across the public sector, private sector, municipalities, and NGOs. The study discusses the capacity of these cooperatives to create alternative economic models and their political dynamics within the civil society ecosystem. Ultimately, this project intends to provide a comprehensive framework for understanding the challenges and opportunities in sustaining women's labor in rural Turkey.

Seeing Beyond the Text: A Critical Discourse Analysis of ELT Coursebooks for Blind Students in Türkiye

Research Area: Inclusive Education
Project Team Members: Gökçen Altınay Özer and Zehra Ceren Oğuzmert
Project Supervisors: Inst. Dr. Çiğdem Fidan

Abstract:

This study addresses the often-overlooked needs of Blind students in ELT, particularly within curriculum design and material development. It evaluates the adaptability of ELT course books used at the K-12 level for Blind learners by examining their alignment with MoNE's standards and vision, and by comparing them with contemporary global paradigms in language education (UNESCO, 2021). Adopting a qualitative research approach grounded in the social model of disability, the study is employed as a case and uses critical discourse analysis to examine K-12 ELT course books used with Blind students in Türkiye. Semi-structured interviews with Blind students and ELT teachers further explore their perceptions of the inclusiveness of these materials. The findings aim to contribute to a framework for developing Inclusive curricula and course books that support meaningful differentiation and effectively meet the learning needs of Blind ELT students.

Demonstration of the PiT2 Expression in U87-MG Cell Line via Optimized PiT2-Specific Primers

Research Area: Neurobiology of Disease
Project Team Members: Ayşe İrem Güler, Selen Altıntaş, Nazlı Gül and Ebru Kavaklı
Project Supervisors: Assoc.Prof. Erkan Kiriş

Abstract:

PiT2 is a Type III sodium-dependent phosphate transporter that regulates inorganic phosphate (Pi) transportation, and it has a housekeeping role in Pi homeostasis in mammalian cells. Also, it is one of the main Pi transporters in the mouse and human brain. In addition, glioblastoma multiforme (GBM) is a brain tumor classified as the most malignant and highly aggressive tumor. Based on previous research, the inorganic phosphate transporter pathway may be linked to cancer biology. In this research, we aim to demonstrate the PiT2 expression in the U87-MG cell line, which is a GBM cell line, since it could help the understanding of the correlation.

Generating Synthetic Data in Unreal Engine 5 and Blender 3D to Train Computer Vision Models Used in Drones for Earthquake Rescue

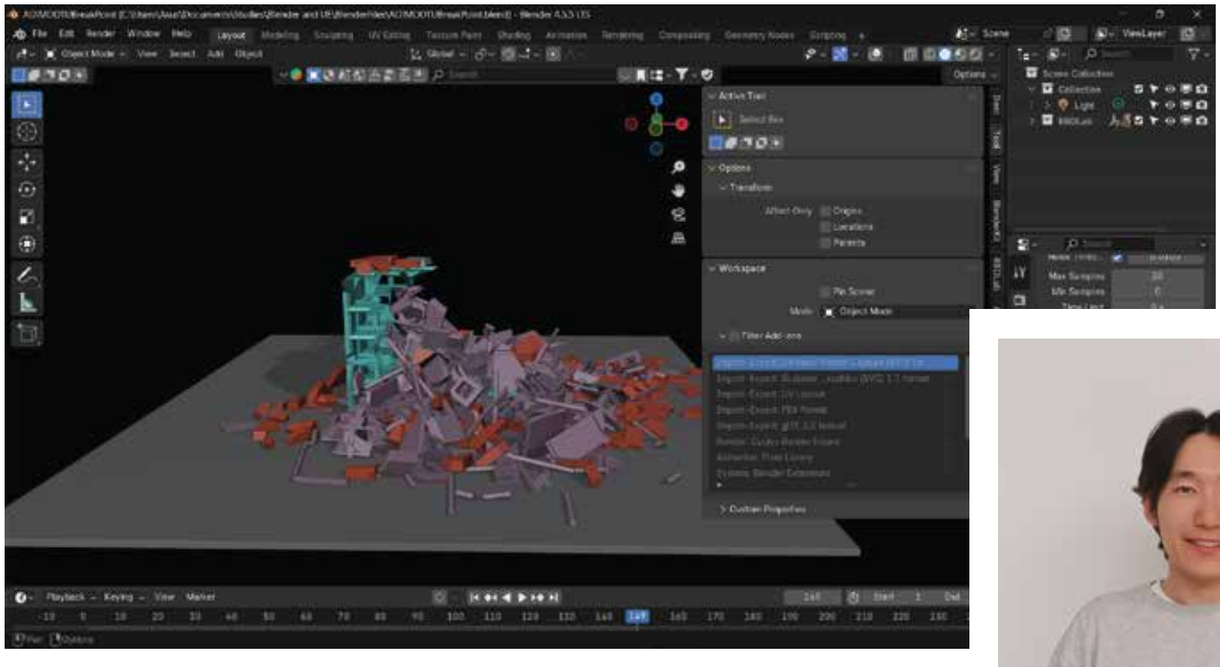
Research Area: Synthetic Data for Machine Learning

Project Team Members: Sanzhar Zhanagizov

Project Supervisors: Assist.Prof. Güzin Şen

Abstract:

This project investigates how synthetic data can support training computer vision models for drones used in earthquake rescue operations. Since real disaster images are difficult and risky to collect, a simulation-based pipeline is created using Unreal Engine 5 and Blender 3D. Various environments, lighting conditions, debris types, and human positions are generated to build a diverse dataset. This dataset is used to train AI models that help drones detect people and navigate damaged areas. The aim is to show that synthetic data offers a safe, flexible, and scalable way to improve drone-based search-and-rescue performance.

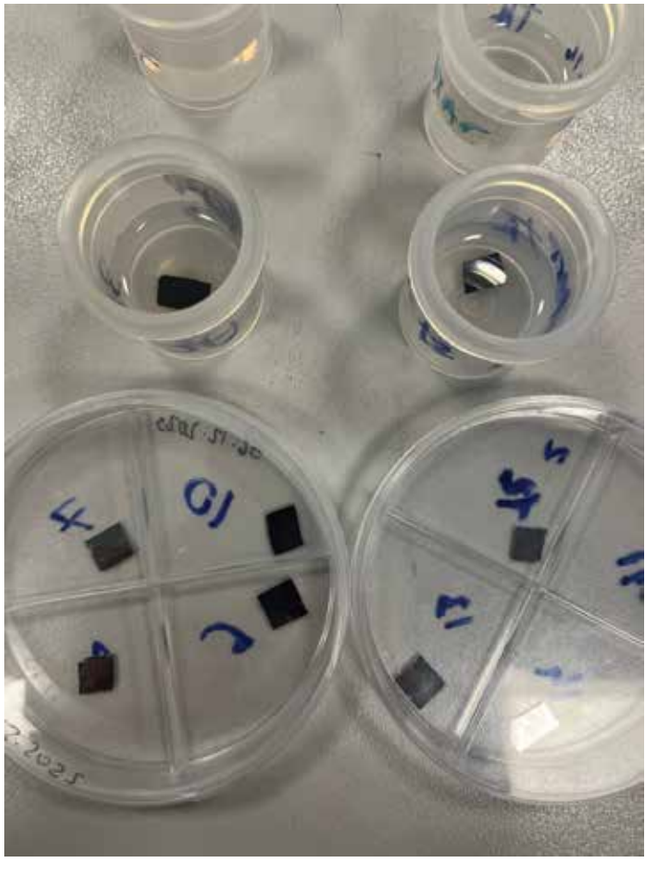


Preparation of Polydopamine-based Multilayer Films and Investigation of Their Antibacterial Properties

Research Area: Physical Chemistry and Polymer Science
Project Team Members: İpek Gençer
Project Supervisors: Prof. İrem Erel Göktepe

Abstract:

Dopamine (DOP) is a biological neurotransmitter found in living organisms and can be derived from mussel adhesive proteins. Dopamine (DA) self-polymerizes to polydopamine (PDA) through pH, heat, and light triggers. It is widely used in biomedical applications. During the polymerization of DOP, reactive oxygen species such as hydrogen peroxide (H2O2) are produced. Reactive oxygen species can damage bacteria and cancer cells by damaging the lipids and proteins of the cell. This study aims to produce ultra-thin multilayer films of DA through the layer-by-layer self-assembly technique and induce polymerization of DA at the surface. Multilayer films is characterized using various techniques such as ellipsometry, atomic force microscopy (AFM), and contact angle measurements. After that, the effect of the number of DOP layers and the amount of H2O2 generated in the multilayers during polymerization on the antibacterial properties of the films will be examined.

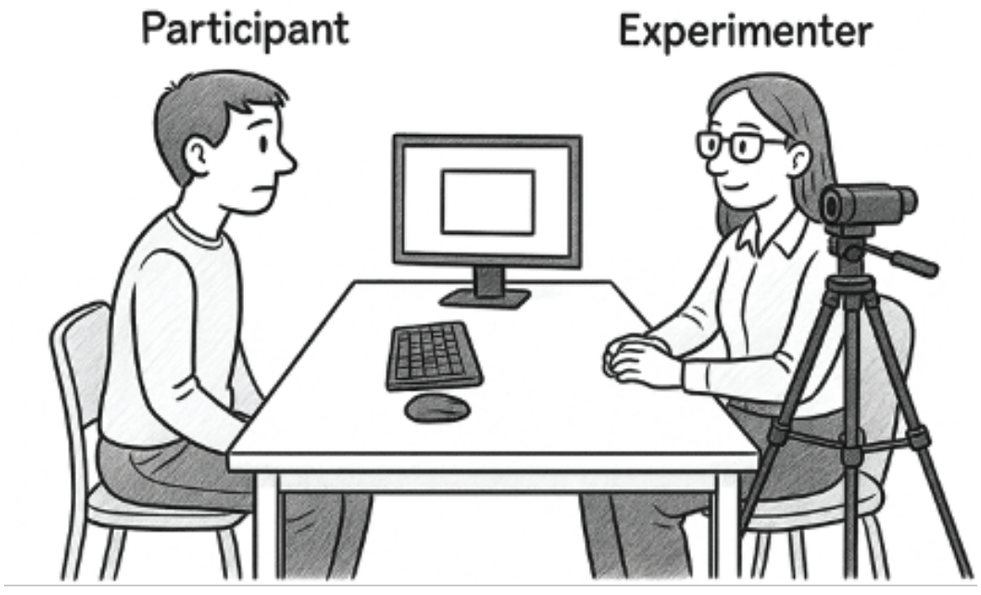


Emotion Expression Across Modalities and Their Links to Emotion Regulation Across the Autism Spectrum

Research Area: Developmental Psychology
Project Team Members: Nesrin Bulut
Project Supervisors: Assist.Prof. Zeynep M. Suata

Abstract:

Background: Emotional communication depends on integrating information across gestures, facial expressions, and speech. Research with neurotypical adults suggests a potential gesture advantage, where gestures accompanying speech convey emotional meaning more effectively than facial or vocal cues alone. However, it remains unclear whether this advantage extends to autistic individuals or supports their emotion regulation processes. This study investigates how autistic and neurotypical young adults (1) express emotions across multiple modalities (facial, gestural, speech) and integrate them, and (2) whether these modality channels relate to emotion regulation differently in ASD compared to neurotypicals. Ninety participants (45 autistic, 45 neurotypical) will complete self-report measures of autistic traits, emotion regulation (DERS), alexithymia (TAS-20), anxiety (BAI), and interpersonal reactivity (IRI), followed by digit span, visual search, and mental rotation tasks. Participants will then complete three gesture-elicitation tasks and an emotion-elicitation task (anger/sadness narratives). Gestures will be coded using ELAN, and facial expressions with the MAX system in MATLAB. Findings will advance understanding of multimodal communication mechanisms in emotional contexts and inform interventions that target socio-emotional functioning in ASD.

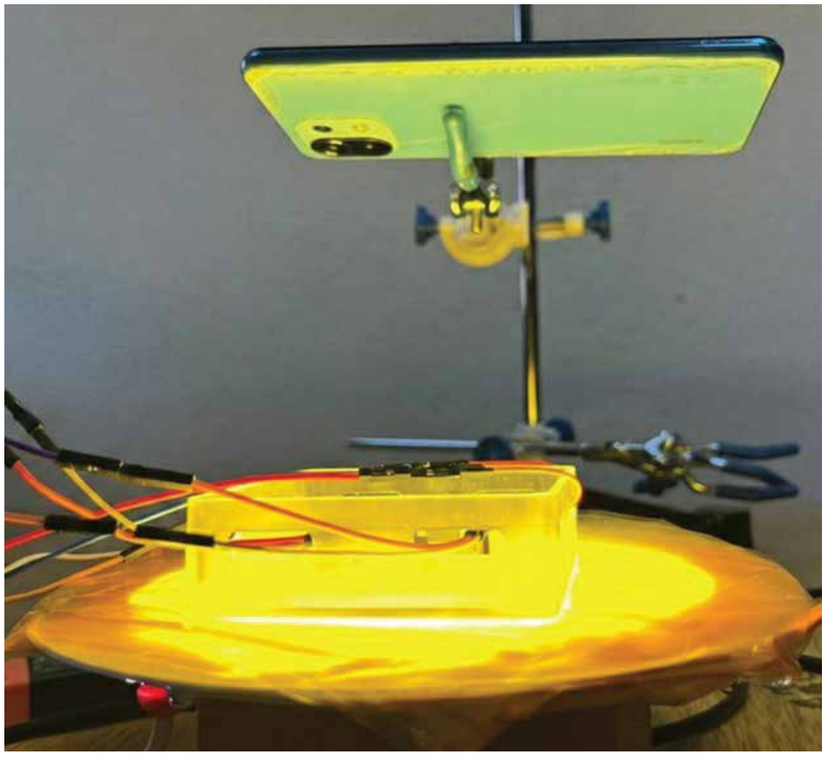


Visualisation and Analysis of Chladni Figures in an SLA 3D Printer Vat using Image Processing

Research Area: MEMS, Microfluidic Systems, Composite Manufacturing
Project Team Members: Begüm Tezcan
Project Supervisors: Assoc.Prof. Ender Yıldırım

Abstract:

This project investigates the acoustic alignment of micro-scale particles within a photopolymer resin. A modified LCD-based SLA system equipped with piezoelectric actuators generates controlled vibration fields that drive particles to self-organize into Chladni-type patterns. Particle distributions are recorded throughout the process, and image-processing routines are developed to extract particle coordinates and quantify alignment quality. The study demonstrates an integrated acoustic-assisted fabrication and image-analysis approach, offering a basis for future anisotropic polymer MEMS, microfluidic systems, and composite manufacturing.



Examining Romantic Relationship Satisfaction and Perceived Partner Responsiveness from the Framework of Attachment and Other-Directedness Schema

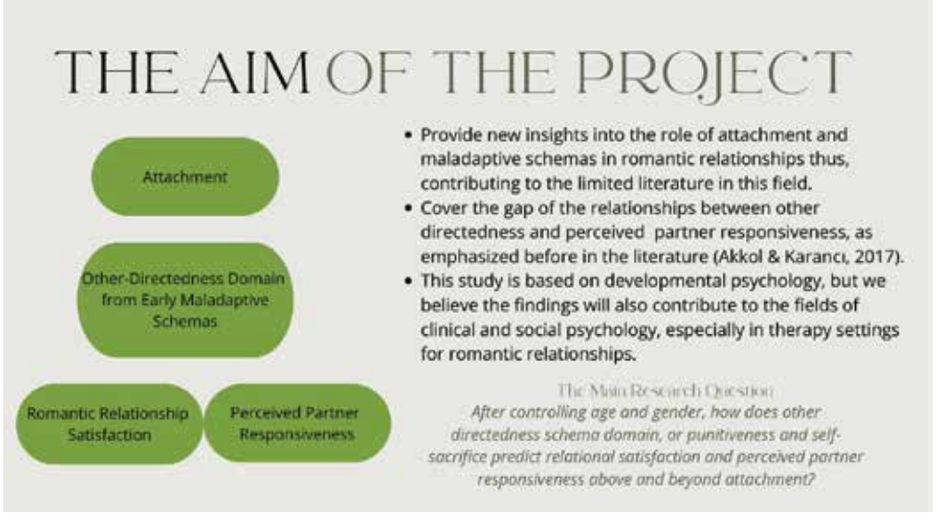
Research Area: Developmental Psychology

Project Team Members: Psk. Defne Akdemir, Nehir Akpınar, Mustafa Kul, Ezgim Küçükoğlu and Aslı Türkoğlu

Project Supervisors: Assoc.Prof. Başak Şahin Acar

Abstract:

The relationship between attachment and early maladaptive schemas is widely investigated in developmental psychology. However, the association between perceived partner responsiveness and other directedness domain of early maladaptive schemas is lacking in the literature. The aim of this study was to contribute to the literature by investigating the role of early maladaptive schemas in the association between attachment, romantic relationship satisfaction and perceived partner responsiveness while controlling for gender and age variables. The sample included 162 university students between the ages of 18 and 24. The hypotheses were confirmed partially. Hierarchical regression analysis revealed that other-directedness domain and attachment significantly predicted perceived partner responsiveness, whereas the role of other directedness domain in this relationship was not significant.



The Understanding and Knowledge of Pre-Service Teachers at METU Regarding AI-Integrated Measurement and Evaluation Practices

Research Area: AI in Education
Project Team Members: Melike Hatun Denden and Selena Deniz Bingöl
Project Supervisors: Assoc.Prof. Engin Karahan

Abstract:

Artificial intelligence technologies are rapidly reshaping education with their widespread use (Dilek et al., 2025). However, teachers' competence and ethical awareness in AI-based assessment and evaluation tools have not been adequately examined (Bae et al., 2024). This study examined the technical knowledge levels of prospective teachers at METU regarding AI-based assessment tools, as well as their perceptions of ethical concerns and trust in technology. This mixed-methods study is one of the few studies that examines prospective teachers' perceptions of AI, disaggregated by their level of technical knowledge. The findings indicate that as their knowledge level increases, prospective teachers evaluate AI not as an abstract threat but based on concrete technical criteria and adopt a more conscious and pragmatic approach. These findings provide concrete evidence for the inclusion of AI literacy and ethics modules in teacher training programs. Therefore, teacher education must be supported by algorithmic logic and data ethics.

Green Engineering Approach to Nutrient Recovery: Optimizing Struvite Production in Fluidized Bed Systems

Research Area: Waste Management, Nutrient Recovery
Project Team Members: Sümeyye Nur Köse and Melek Canbulat Özdemir
Project Supervisors: Assoc. Prof. Yasemin Dilşad Yılmazel Tokel

Abstract:

The recovery of phosphorus from wastewater as struvite (MgNH4PO4 6H2O) precipitation offers a sustainable solution to nutrient pollution and resource depletion. While Fluidized Bed Reactors (FBR) are preferred for producing high-quality pellets, establishing stable hydraulic conditions remains a challenge during the transition from batch to continuous systems. This study aims to optimize critical operational parameters (pH adjustment, HRT, recirculation) of FBR start-up using pure chemicals to ensure process stability. Experiments were conducted in a 2.7 L lab-scale reactor fed with synthetic wastewater (N:P:Mg 1:1:1). Five experimental setups evaluated pH injection points (top vs. bottom) and recirculation regimes to overcome clogging and crystal loss. Results indicated that continuous bottom injection of NaOH, combined with an optimized recirculation rate, successfully stabilized the pH at 8.5–9.0. Under these conditions, the system achieved high recovery efficiencies of 98.7% for phosphorus and 86.8% for nitrogen. These findings establish a reliable start-up protocol, creating a robust foundation for future applications with complex waste streams.

BrailleSteps – Interactive Braille Practice Mat for Visually Impaired Children

Research Area: Assistive Technology / Inclusive Design
Project Team Members: Beste Toprak, Rümeysa Aygündüz, Sema Betül Akkurt and Zhala Imamova
Project Supervisors: Prof. Bahar Şener Pedgley

Abstract:

BrailleSteps is an innovative and interactive Braille practice mat designed to support inclusive and equitable learning for blind and visually impaired children. It offers an enjoyable way to practice the Braille alphabet, helping reduce barriers to quality education and encouraging motivation for lifelong learning. By incorporating movement-based activities, the mat strengthens kinesthetic memory and supports both cognitive and physical development in a natural, child-friendly manner. Its playful yet structured design helps children build confidence, improve communication skills, and feel more included in learning environments. With its high-contrast colors and accessible layout, BrailleSteps becomes a powerful educational resource that promotes equal learning opportunities and meaningful engagement for learners.

Exploring the Formation of Pseudo-Onomatopoeic Words In Multimodal Material Perception

Research Area: Psychology, Cognitive Psychology (Sensory Perception)
Project Team Members: İlknur Zeynep Kaya
Project Supervisors: Assoc. Prof. Dicle N. Dövencioğlu

Abstract:

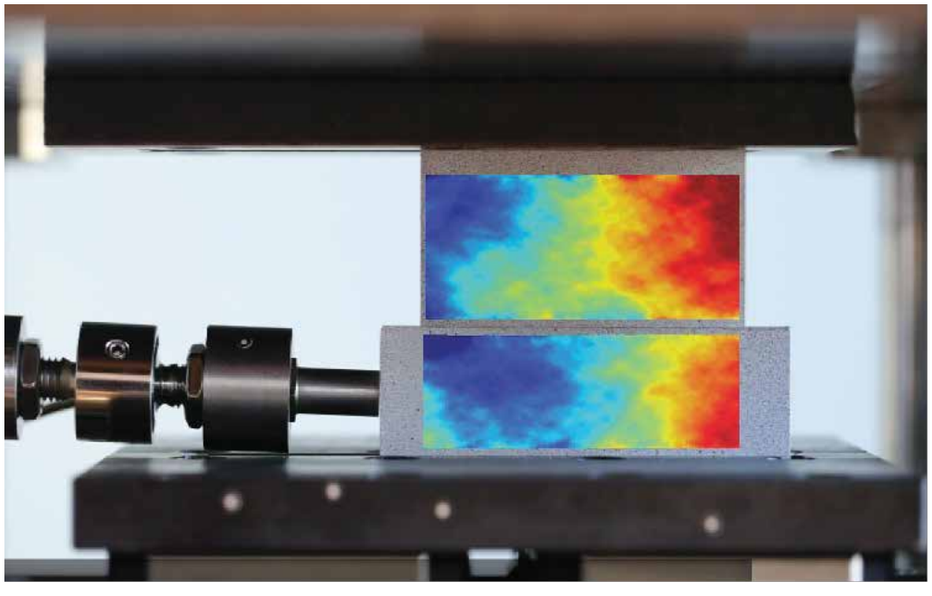
The majority of words used in spoken languages are based on linguistic arbitrariness, indicating that there is no inherent connection between a word's meaning and its sound or form. On the contrary, sound symbolism demonstrates a non-arbitrary relationship between phonetic properties of words and their meanings, which exhibits an inherent link between sound and sense (Dingemanse et al., 2015). Accumulating research has shown that certain phonemes are associated with specific material properties, especially in the Japanese language (Sakamato & Watanabe, 2018). Recent work has also demonstrated that existing Turkish onomatopoeic words, which are a subset of sound-symbolic words (SSWs), can selectively alter perceived material properties (Nalbantoğlu et al, 2024). Building on this background, the current study aimed to investigate the formation of novel Turkish pseudo-onomatopoeic words in response to visual and haptic experiences of different materials across five different dimensions. For both modalities, analyses revealed strong within-dimension correlations and systematic inter-dimensional associations, with Hard and Metal materials clustering together and Fluids forming the most distinct category; these relational patterns were reflected in dimension-specific phoneme distributions, indicating a correspondence between material properties and sound–symbolic word formation.

Experimental Investigation of Frictional Sliding Instability

Research Area: Friction and Contact Mechanics, Experimental Solid Mechanics
Project Team Members: Gülcenaz Baygeldi
Project Supervisors: Prof. Demirkan Çöker

Abstract:

Friction controls how objects move against each other in natural and engineered systems. Frictional sliding can be smooth and stable, or unstable occurring through irregular motion termed 'stick–slip', in which the sliding interfaces alternates between being stuck and sliding. One factor thought to strongly influence frictional sliding behavior is the condition of the contacting surfaces, since real interfaces are never perfectly smooth. As a result, surface roughness becomes important because sliding surfaces do not make contact everywhere, but only at small, uneven contact points along the interface. In this study, we explore how surface roughness influences frictional sliding instability experimentally. Sliding surfaces with different roughness levels were prepared using cutting techniques and polishing with sandpaper. Friction tests were conducted in an in-house friction setup, and surface deformation were measured using Digital Image Correlation which is a far-field method. Comparing the results shows how changes in roughness affect the transition from steady sliding to stick–slip.



Academic Maturity Research Project

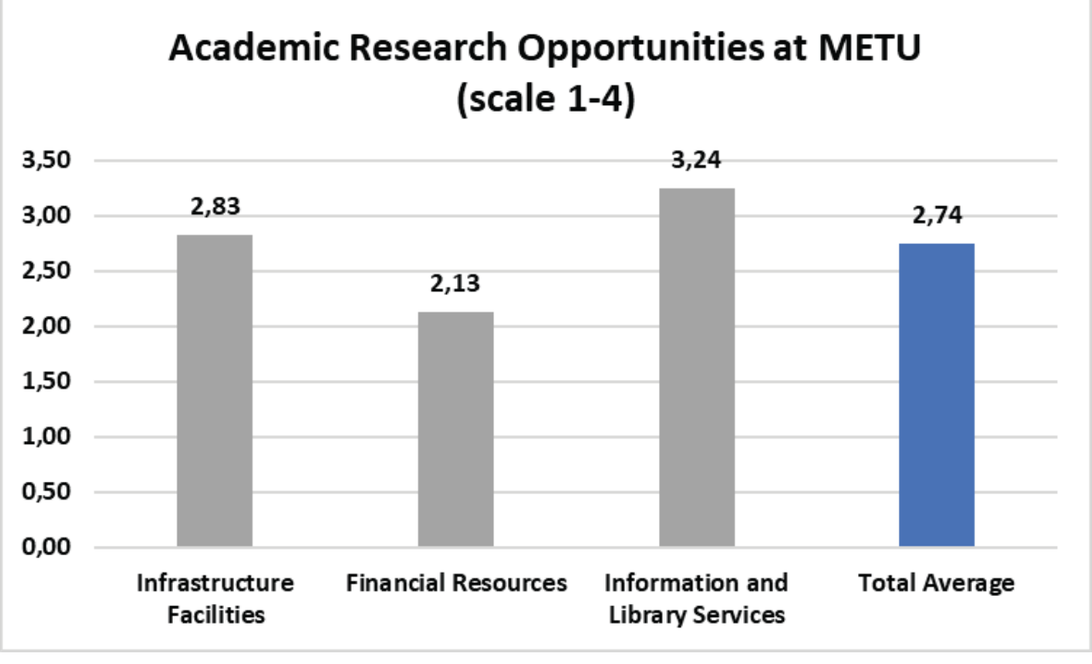
Research Area: Social Sciences

Project Team Members: Ayçasu Akkavak, Nazenin Aliyeva, Enescan Ilık, Özgür Işıldak, Ali Oğuz Kireç, Nihad Mammadli, Begüm Somay, Nazlı Deniz Sönmez, Niyazi Emir Tekin, Ayşegül Gökçe Yıldırım, Mert Yıldız and Bilgehan Yürek

Project Supervisors: Assoc.Prof. Serap Emil

Abstract:

The Academic Maturity Research Project is designed to examine the extent to which undergraduate students at the Middle East Technical University (METU) campus perform academic research and to identify the factors influencing this tendency. Within the scope of this study, a comprehensive literature review was conducted regarding the academic maturity concept, and a survey was carried out with 254 METU students. The survey examined factors such as students' academic research experience and academic interests. In addition, comparisons were made between METU and other universities, detailed comparisons were made between departments and faculties within METU, and the trend in academic maturity over recent years was examined and interpreted. Finally, the article writing process has begun.



METU
SEARCH AND ORGANIZATION
SOCIETY

Real-Time Electrical Source Imaging of the Human Brain Using EEG Data and Machine Learning

Research Area: Biomedical Signal Processing, Neuroimaging, Machine Learning, EEG Source
Project Team Members: Aleyna Şener and Kaan Uştu
Project Supervisors: Prof. Nevzat Güneri Gençer

Abstract:

Electroencephalography (EEG) source localization is critical for understanding the spatiotemporal dynamics of brain function but is hindered by the ill-posed nature of the inverse problem. This project evaluates a hybrid "Physics-Informed" deep learning approach against traditional inverse solvers. We implemented a 2D-PIUNet, a simplified adaptation of the 3D-PIUNet architecture, which refines the solution of a physics-based method (eLORETA) using a U-Net neural network. Using a custom MATLAB simulation environment, we compared this hybrid model against conventional methods like Tikhonov regularization, sLORETA, and Greedy TSVD. Our results demonstrate that the 2D-PIUNet effectively overcomes the limitations of traditional priors, offering superior localization accuracy and robustness to noise by learning a data-driven prior while retaining the geometric constraints of the forward model.

AI in Solving Socioscientific Issues Through Ethical Decision Making

Research Area: Artificial Intelligence
Project Team Members: Süleyman Yılmaz and Sena Çelik
Project Supervisors: Assoc.Prof. Engin Karahan

Abstract:

With this project, we brought together different disciplines to investigate how artificial intelligence, one of today's most pervasive developments, approaches controversial issues of all time. Drawing on socio scientific issues, we presented interdisciplinary data from numerous fields, both local and global, with cases encompassing numerous scientific, societal, and ethical values. We measured AI's reactions to this data. While it's nearly impossible to draw a definitive conclusion because these are issues that can be viewed from different societal perspectives, we explored AI's response to these scenarios. We presented AI with our own scenarios one by one, asking it to reach a clear conclusion and explain the details of how it arrived at this decision. Our research aimed to answer questions such as whether its responses yielded a clear conclusion, which values it prioritized, and whether it could be considered a decision-maker.

Unlocking the Power of Hypericum Perforatum L.: An IR780 Sequential Strategy Against Glioblastoma

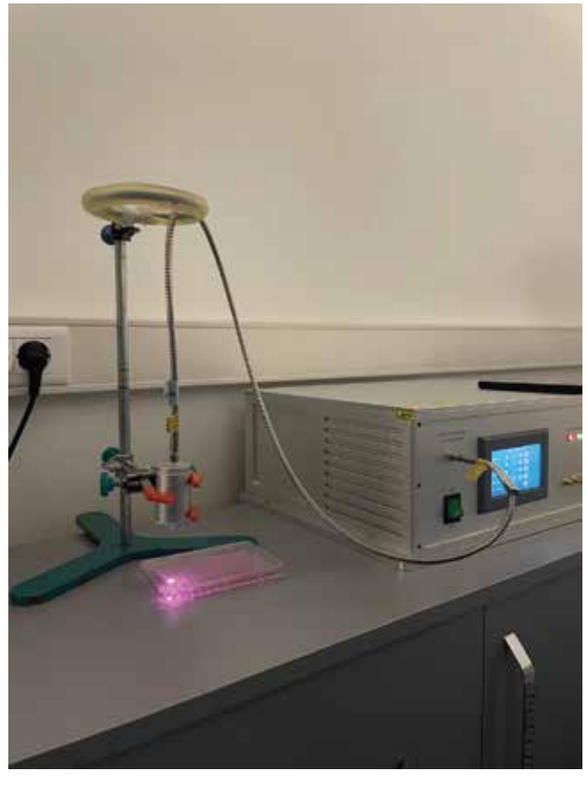
Research Area: Biochemistry

Project Team Members: Selin Fatma Güney, Ebrar Dilek Yiğiter, Mehmed Melih Yiğiter and Dila Sultan Uyar

Project Supervisors: Prof. Emrullah Görkem Günbaş

Abstract:

This project investigates a novel combinational photodynamic therapy (PDT) approach targeting highly aggressive human glioblastoma cell lines, T98G and U118. The combinational strategy was designed to utilize the dual mechanism of IR780 followed by the powerful cellular stress induced by Hypericin. The near-infrared dye IR780 was initially applied, activated by an 808 nm laser, which triggers simultaneous PDT and PTT (Photothermal Therapy) effects . Subsequently, the natural compound Hypericin extract, from Hypericum Perforatum L., was applied, activated by a 590 nm LED, initiating PDT, induced cellular stress to complete the sequential killing mechanism, and the cells were then incubated overnight. Our results aim to confirm that neither compound exhibits significant dark toxicity. By exploiting the dual PDT and PTT mechanism of IR780 to initiate damage and the delayed Hypericin exposure to maximize cellular stress, we seek to demonstrate a synergistic effect, offering a promising, targeted treatment paradigm.



Inflation Research Project

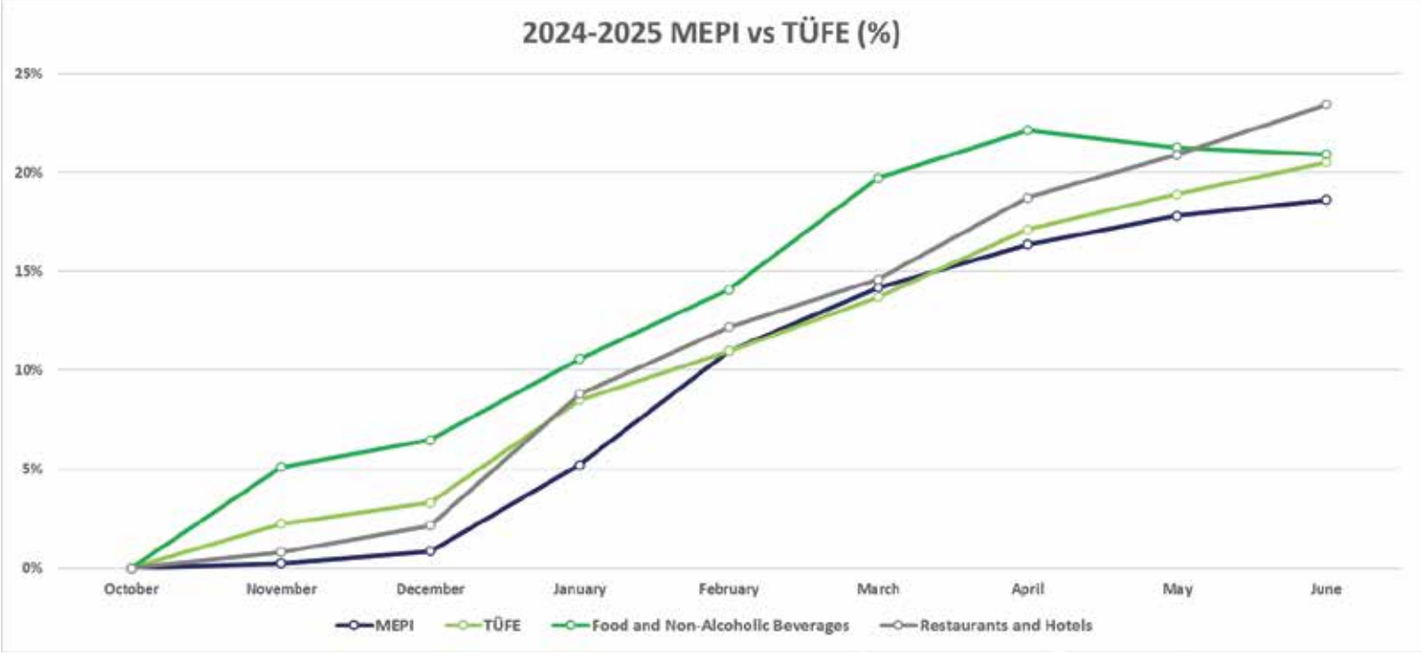
Research Area: Social Sciences

Project Team Members: Zeynep Gökçe Abaş, Nazenin Aliyeva, Berat Hüseyin Ayar, Muazzez Demir, Enescan Ilık, Zeki Mert Korkmaz, Nihad Mammadli, Begüm Somay, Nazlı Deniz Sönmez, Mehmet Ali Şahin, Niyazi Emir Tekin, Ayşegül Gökçe Yıldırım and Bilgehan Yürek

Project Supervisors: Prof. Sinan Gürel

Abstract:

The Inflation Research Project aims to regularly calculate inflation at the METU campus every year with an index called MEPI (METU Price Index). Prices are collected every month from all food businesses at METU for the MEPI index, and the prices of representative products are aggregated in Excel. Additionally, a survey was conducted with 193 METU students to create the METU inflation basket. As a result of the study, the index was created, with October 2023 taken as the base month, and the two-year METU inflation rate was calculated. Finally, the article writing process has begun.



METU
SEARCH AND ORGANIZATION
SOCIETY

Orbital Period Change Analyses of Exoplanets with Shortening Orbits

Research Area: Astrophysics, Exoplanetary Science, Astronomy and Space Sciences
Project Team Members: Zeynep Zengin, Ebrar Akalın, Volkan Özsoy, Özdenur Yaldır and Dilara İçöz
Project Supervisors: MSc. Ahmet Cem Kutluay, Assoc. Prof. Sinan Kaan Yerli and Prof. Özgür Baştürk

Abstract:

This research investigates the orbital evolution of "Hot Jupiters" conducted by students from METU Physics Education and Physics Departments. Due to their short orbital periods and high masses, these exoplanets are ideal laboratories for testing tidal dissipation, which are expected to cause "orbital decay" (a shrinking orbit) over time due to angular momentum transfer with their host stars. The project analyzed six Hot Jupiters: CoRoT-2b, KELT-16b, WASP-19b, WASP-46b, WASP-87b, and WASP-114b. The team combined photometric data from the TESS space telescope and literature with their own new ground-based observations to extend the transit baselines. Using Transit Timing Variation (TTV) analysis, they statistically compared "Constant Period" and "Orbital Decay" models.

NGO's Position in Legislation: Comparative Cases of Mexico and Turkey

Research Area: Political Science and Public Administration
Project Team Members: Tuna Kümür
Project Supervisors: Prof. Aylin Topal

Abstract:

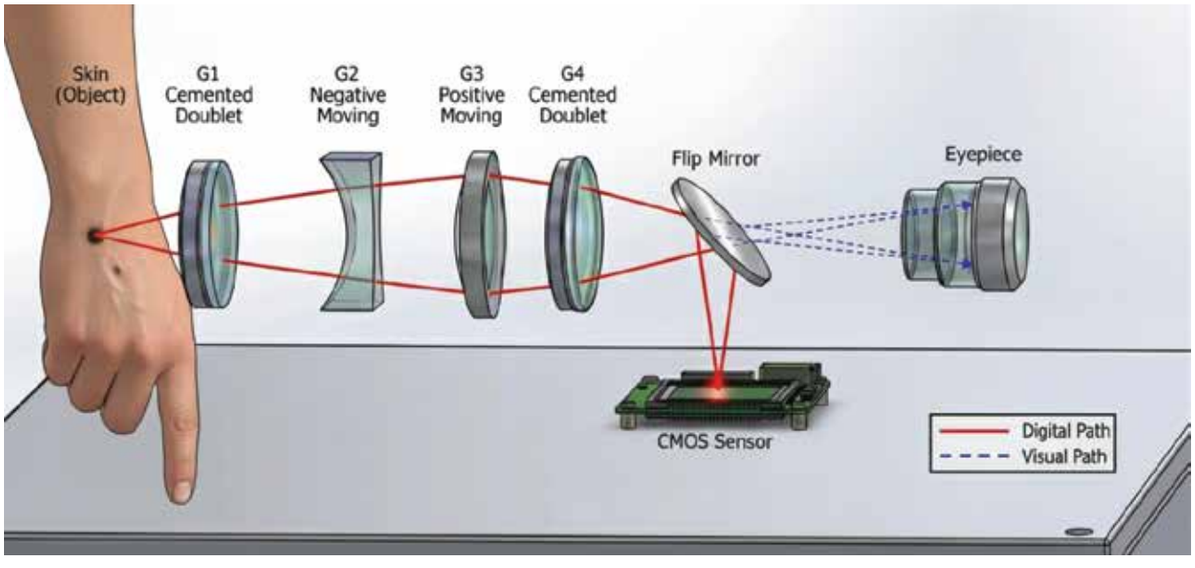
In the summer of 2024, the Turkish Parliament (TBMM) changed its Animal Protection Law with an anthropocentric perspective. The new law requires local governments to collect all stray animals from the streets to be put in shelters and even euthanize them if not adopted within a time limit. On the other hand, within the same year, Mexico changed its constitution to include the protection of animal rights and animal welfare in school curricula. These opposite results from contemporary governments have piqued our interest, and we decided to investigate some of the active actors, mainly NGOs, to see what may have been the cause.

Development of an AI-Assisted Dermatoscope for Early Diagnosis of Skin Cancer

Research Area: Optical Engineering, Deep Learning, Biomedical Imaging, Medical Physics
Project Team Members: Ahmet Sünbül and Buğra Akkuş
Project Supervisors: Prof. Ahmet Bingül

Abstract:

Malignant melanoma is an aggressive skin cancer where early detection is paramount for survival. Although Deep Learning has achieved expert-level diagnostic potential, deploying these models in portable clinical tools remains a challenge. This project introduces a Dual-Mode AI-Assisted Dermatoscope designed to seamlessly bridge clinical examination with automated diagnosis. Building upon advanced videocapillaroscopy architectures, we engineered a hybrid optical system featuring a flip mirror mechanism to switch between direct visual observation and digital capture. To enhance diagnostic precision, the design incorporates Cross-Polarization and Green (540nm) Light for superior vascular contrast. The system integrates a lightweight EfficientNet-B4 model to classify seven distinct skin lesion types in real-time. Validated on the HAM10000 dataset with 84.63% accuracy, this device serves as an immediate, automated second opinion, aiming to augment clinical decision-making and accuracy.



Analysis of Creatine Kinase Brain Isoform (CKB) Gene Expression in Three Breast Cancer Cell Lines

Research Area: Breast Cancer

Project Team Members: Aynur Novruzova and Didem Naz Dioken

Project Supervisors: Prof. A. Elif Erson Bensan

Abstract:

This project aimed to determine the gene expression profile of Creatin Kinase Brain isoform (CKB) gene in three different breast cancer cell lines. Differential expression of CKB was associated with poor prognosis in Luminal A subtype of breast cancer and it is known to play role in aggressive subtypes. The expression in MCF-10A cells were confirmed but not quantified. The gene expression between cancer subtypes demonstrated a similar expression. This may indicate that the role and expression of CKB may be finely regulated and further research is necessary to detect possible role of CKB in Luminal A subtype of breast cancer.

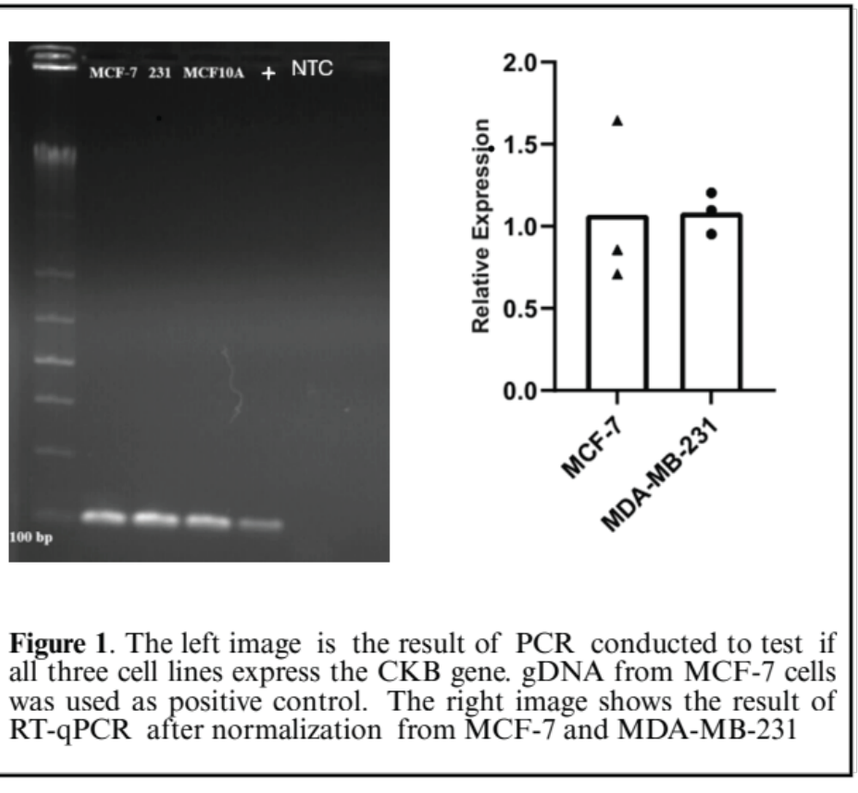


Figure 1. The left image is the result of PCR conducted to test if all three cell lines express the CKB gene. gDNA from MCF-7 cells was used as positive control. The right image shows the result of RT-qPCR after normalization from MCF-7 and MDA-MB-231

The Young Children's Perception of Artificial Intelligence (AI)

Research Area: Artificial Intelligence, Early Childhood Education
Project Team Members: Firuze Efe, Emine Deveci and Nurettin Çelik
Project Supervisors: Assoc.Prof. Volkan Şahin

Abstract:

The project titled "The Young Children's Perception of Artificial Intelligence (AI)" is a pioneering study that aims to examine the perceptions of children in the early childhood period (ages 5-6) regarding artificial intelligence (AI), targeting a critical gap in the literature. Although there is strong evidence that AI can contribute to early childhood education through personalized learning processes, existing research has primarily focused on pedagogical applications or system design. The main objective of the research is to thoroughly examine the current perceptions, knowledge levels, and attitudes of children aged 5-6 towards AI and AI-supported technologies. Within this framework, the study aims to determine how children define AI, what concrete entities (robots, humans, etc.) they associate it with in their minds, the level of anthropomorphic (human-like) characteristics they attribute to AI, and their sources of information (TV, parents, school, etc.).

Dynamic Modeling of the Ultrasonic Welding Machine

Research Area: Micromanufacturing, Polymer MEMS
Project Team Members: Ozan Özdinç
Project Supervisors: Assoc.Prof. Ender Yıldırım

Abstract:

Ultrasonic welding machines are widely used for the welding and embossing of polymers, where localized heating is generated by high-frequency, low-amplitude vibrations transmitted through a sonotrode. At the METU Micromanufacturing Laboratory, ultrasonic embossing is investigated as a manufacturing method for producing microchannels in Lab-on-a-Chip devices, which can be used for point-of-care diagnostic applications. The heating and deformation induced by ultrasonic excitation are strongly governed by the vibration characteristics of the sonotrode, making these vibration characteristics critical to process performance. In this project, the machine dynamics are modeled to estimate key vibration characteristics—such as amplitude and penetration—and to evaluate their dependence on machine settings. As part of this AdımODTÜ undergraduate research project, a SIMULINK-based model was developed which captures the thermomechanical coupling between ultrasonic heat generation and the resulting vibration behavior.

Alternative Protein from Apple Pomace: Biotechnological Transformation

Research Area: Food Biotechnology
Project Team Members: Dila Çınar, Deniz Sevim Çabuk and Ayşe Sultan Akgün
Project Supervisors: Prof. Mecit Halil Öztop

Abstract:

This study investigated the microbial hydrolysis of pectin-removed apple pomace to enhance reducing sugar and protein content using co-cultures of Saccharomyces cerevisiae and Kluyveromyces marxianus. The effects of solid load (5%, 10%, and 15%), inoculum volume (1%, 2%, and 3%), and fermentation period (1, 2, and 3 days) were evaluated at 30°C and 200 rpm. Reducing sugar and protein concentrations were analyzed using the DNS and Kjeldahl methods, respectively. Results revealed that solid load was the most significant factor affecting yield. While maximum sugar conversion occurred at 5% solid load, the highest protein concentration of 10.68% was achieved at 10% solid load with a 2% inoculum. Higher solid loads (15%) reduced efficiency due to mass transfer limitations, indicating that 10% solid load represents the optimal balance for scalable protein-rich biomass production.

Neighborhood-Based Earthquake Risk Prediction: An Integrated Machine Learning

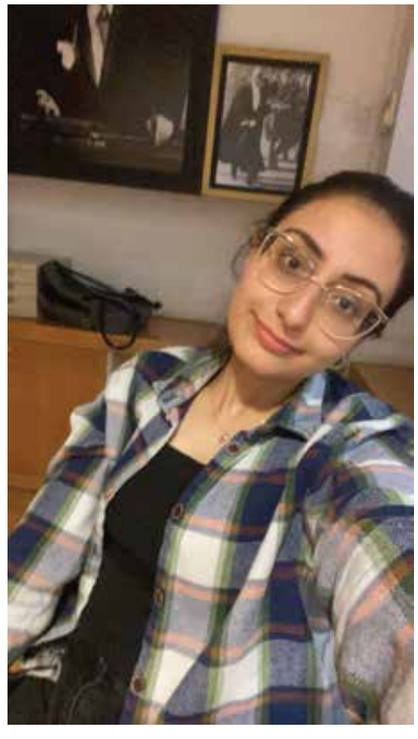
Research Area: Earthquake Risk Modeling, Disaster Management, Machine Learning, Spatial Statistics

Project Team Members: Buğra Akkuş and Mürüvvet Eda Koyuncu

Project Supervisors: Prof. Berna Burçak Başbuğ Erkan

Abstract:

This project introduces a data-driven approach to earthquake risk assessment in Turkey, shifting from static administrative boundaries to dynamic "Seismic Neighborhoods." Using more than 19,000 earthquake records from USGS and AFAD (1990–2025), we applied DBSCAN clustering to identify active seismic zones and then used Voronoi Tesselation to model regional risk partitions. Each region was assigned a risk score based on seismic intensity and event frequency. Kernel Density Estimation (KDE) was additionally used to predict future earthquake probability distributions. The results reveal that seismic risk is highly localized and that neighborhood-level early warning systems may offer more actionable insights than province-level alerts. This research provides a rigorous, data-driven framework to support more precise, scientifically informed disaster preparedness strategies.



Talking Ourselves Through It: Linguistic Distance as a Tool for Emotion Regulation in TurkishApproach

Research Area: Psychology

Project Team Members: Songül Büyükköse

Project Supervisors: Assist.Prof. Zeynep M. Suata

Abstract:

Emotion regulation involves shaping which emotions we experience and how we express them. One adaptive strategy is psychological distancing, which refers to stepping back and viewing an emotional event from a broader, more objective perspective. Prior research shows that distancing can be observed in language use, such as reduced first-person singular pronouns or greater use of passive structures in expressive writing. However, most evidence comes from English-speaking samples. Turkish, with its agglutinative structure, pronoun dropping, SOV word order, and evidential markers, may differ in how psychological distancing is expressed. Aim: This study examines how self-reported emotion regulation strategies (e.g., self-blame, acceptance, rumination, putting into perspective, emotional clarity) relate to linguistic markers of psychological distancing in expressive writing. We will recruit 150 healthy Turkish-speaking adults (aged 19–55) who will complete self-report measures of emotion regulation and affect, as well as two expressive writing tasks completed across two lab sessions. Linguistic markers of distancing will be quantified using the Linguistic Inquiry and Word Count (LIWC) software. Findings will improve our understanding of how linguistic features of written expression relate to emotional processing and how emotions are regulated through language. This may help explain why expressive writing benefits mental health and supports the development of writing-based psychological interventions.

Analysis of Simulated Cell Behaviour and Patterns

Research Area: Computational Biology
Project Team Members: Ozan Durmaz, Emre Özcan, Mete Balçık and Arda Özbey
Project Supervisors: Assist. Prof. Aybar Can Acar

Abstract:

Understanding how genotypic changes occur longitudinally has been a core problem of evolutionary biology and often requires costly settings with inconsistent results. To overcome this, we developed a 2D simulation framework that models biotic units capable of movement, feeding, and under suitable conditions, reproduction. Their behavior changes through interactions among genome-based neural network controllers, internal parameters such as metabolic energy state, and sensed environmental conditions. The units reproduce and inherit their genomes with varying mutation factors, introducing variation in population level. Preliminary runs show that the framework functions as intended for modeling basic evolutionary patterns and helps identify areas that require further refinement. The framework provides a basis for future work on adaptive behavior, evolutionary paths, and modeling biotic and abiotic reproductive units, with efforts continuing on improving simulation stability.

Recollection of Collective Heritage: Tatbikat Stage

Research Area: Architectural Conservation

Project Team Members: Sezi Aydın, Ilgın Eylül Aytekin, Duru Deniz and Nehir Koyğun

Project Supervisors: Assoc. Prof. Pınar Aykaç Leidholm

Abstract:

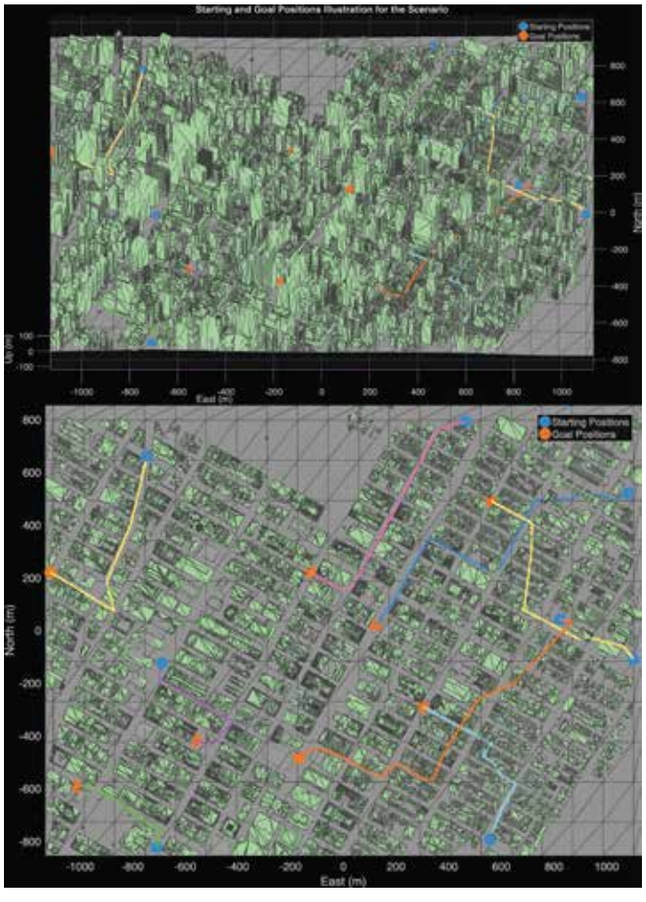
The establishment of the Turkish Republic sets an incentive to raise the citizens' engagement in sociocultural activities. This brought along the newly constructed theaters, developing and encouraging a cultural scene in which art can be experienced by everyone. This study focuses on the theatre building that lost its cultural significance throughout the 20th century: the Tatbikat Stage. Even though this stage is currently active as a private theater, as a modern heritage, it does not receive the attention it deserves from the public. This is analyzed under three main aspects: establishment and development of the Tatbikat Stage, its sociocultural effects in Ankara, and how it can be reintroduced to the public as a heritage place.

Multi-UAV Path Planning for Urban Air Mobility

Research Area: Aerospace Engineering, Urban Air Mobility, Autonomous Systems
Project Team Members: Ömer Faruk Yağız
Project Supervisors: Assoc.Prof. Halil Ersin Söken

Abstract:

Urban Air Mobility (UAM) is a rapidly advancing field, yet existing literature fails to address many aspects of realistic frameworks. This study aims to develop an integrated path planning framework for multiple unmanned aerial vehicles (UAVs), ensuring collision-free and efficient navigation in real-world urban environments. The system utilizes OpenStreetMap data to generate 3D environments for object-avoidance trajectories. Using OpenStreetMap data provides the flexibility to apply the system anywhere in the world. Evaluations of Probabilistic Roadmap (PRM), RRT, Bi-RRT and RRT* were conducted in high-density urban areas such as Manhattan, Chicago and Hong Kong. The results indicate that Bi-RRT offers the most robust balance of computational speed and optimality, whereas PRM is unsuitable for complex urban densities. This solution offers significant potential for UAM and future logistics.



EBAM: eSIM Bidding and Allocation Model

Research Area: Wireless Networks, GSM, Embedded Systems, Secure-on-Chip Technologies, Identity Management, Mobile Networks

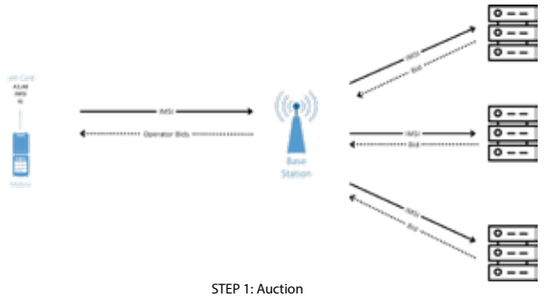
Project Team Members: Ömer Kılınç

Project Supervisors: Prof. Ertan Onur

Abstract:

This paper introduces eBAM, a dynamic provisioning model that replaces static, long-term mobile operator subscriptions with session-based auctions for cellular connectivity. In this model, Mobile Network Operators (MNOs) bid to provide service at the beginning of each mobile network session. The core contribution of this work is demonstrating that such an auction-based system can be implemented using existing eUICC technology without requiring major architectural changes. By selectively updating operator-specific profile attributes on the device—rather than performing full profile switches—eBAM minimizes latency and operational overhead. This approach establishes the feasibility of real-time operator competition and user-centric network selection within current cellular infrastructures, enabling more flexible, efficient, and cost-aware mobile connectivity models.

METHODOLOGY



STEP 1: Auction

STEP 2: Selection

STEP 3: Allocation & Provision

METUORBIT Model Satellite

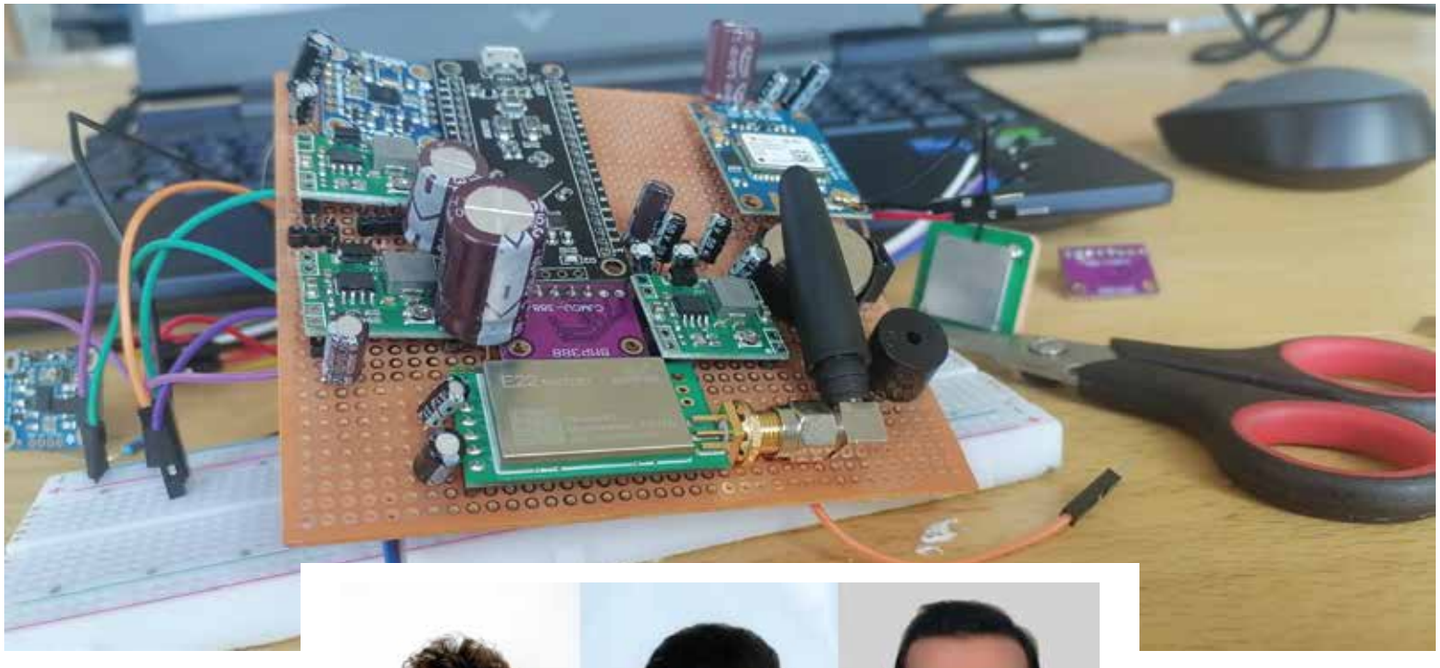
Research Area: Satellite Systems

Project Team Members: Burak Berkiten, Tuana Arıkan, Ayşenur Atalay, M. Selim Seçkiner, Hasan Gökaydın and M. Mirze Kerenciler

Project Supervisors: Prof. Erhan İlhan Konukseven

Abstract:

METUORBIT team aimed to develop a model satellite which has unique mechanical design, electronic system, and operational mechanisms to participate in the TEKNOFEST Model Satellite Competition.

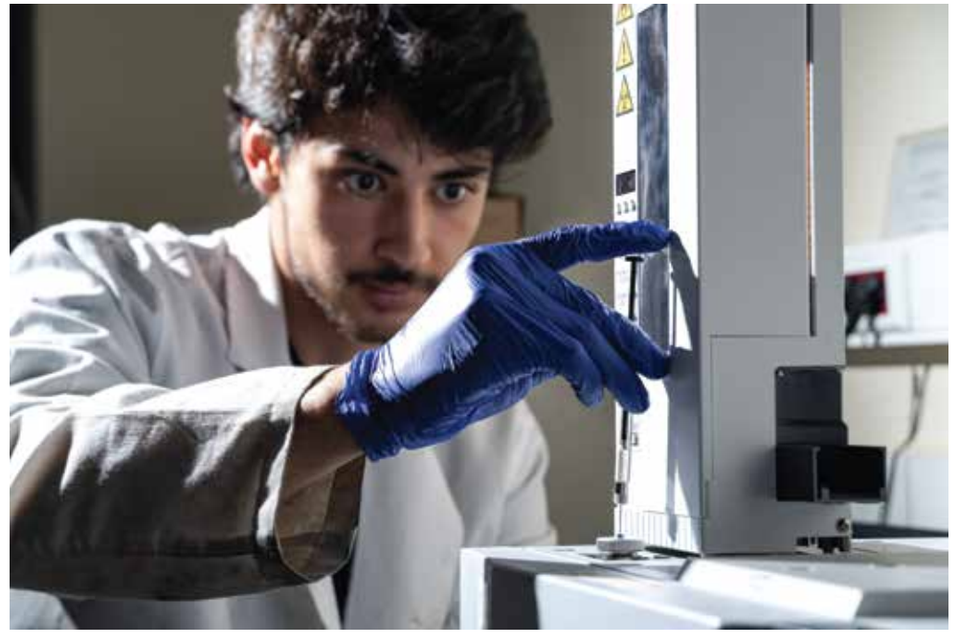


Novel Electrode Preparation and Testing in Electrochemically Assisted Biogas Production

Research Area: Optimization of Bioelectrochemical Systems in Anaerobic Digestion
Project Team Members: Enes Kartopu and Berkan Öden
Project Supervisors: Assoc. Prof. Yasemin Dilşad Yılmazel Tokel

Abstract:

In this project, the focus is on the investigation of high surface area electrodes on a bioelectrochemically assisted biogas production system. Electrostatic flocking is a method used to produce electrodes for applications such as supercapacitors and fuel cells, yet it has never been tested in a bioreactor setting. However, the high surface area is beneficial for biofilm attachment and may prove to be a good alternative to conventional planar electrodes. Therefore, in this experimental work, the impact of electrostatically flocked electrodes on methane production in integrated anaerobic digestion– microbial electrolysis cells (AD-MECs) will be investigated. The performance will be evaluated using synthetic wastewater in single-stage batch reactors.



Identifying Challenges and Creating a Support Platform for Mathematics Teachers in Adapting to Türkiye's New Century Maarif Model

Research Area: Mathematics Education

Project Team Members: Yaren Başgül, Sercan Karabacak, Arda Arsever and Gülsüm Saluvan

Project Supervisors: Prof. Ayhan Kürşat Erbaş and Assoc.Prof. Bülent Çetinkaya

Abstract:

METU CORE is an educational platform developed by senior mathematics teacher candidates at Middle East Technical University, with support from the AdımODTÜ program. The project addresses the possible challenges arising from the implementation of the Türkiye's New Century Maarif Model. Through rigorous curriculum analysis and consultation with in-service teachers, we identified a significant gap between the curriculum's theoretical framework and its practical application in the classroom. METU CORE serves as a digital bridge to close this gap. It is a collaborative platform designed to disseminate high-quality teaching materials, innovative lesson plans, and interpretive guides tailored to the new standards. By pooling the fresh perspectives of pre-service teachers with the experiential knowledge of active educators, this collaborative platform aims to facilitate a smoother adaptation process, ensuring that the new model is delivered effectively and meaningfully in mathematics classrooms.

Pyrolysis of Polylactic Acid over Nickel-Silica Aerogel Catalyst: Products Yields and Distributions

Research Area: Sustainability, Reaction Engineering

Project Team Members: Yiğit Bora Çulha

Project Supervisors: Prof. Naime Aslı Sezgi and Assoc.Prof. Çerağ Dilek Hacıhabiboğlu

Abstract:

Polylactic acid (PLA) is a non-petrol-based plastic that can be produced by fermentation and later polymerization of organic matter (corn, sugarcane, sugar beet pulp starch). PLA is a strong alternative to replace common petroleum-based plastics such as PET, as PLA production is renewable. In Türkiye, PLA production and market size is expected to increase from a market size of 17.7 million US$ to 68.2 million US$ by 2030 [1]. To decompose PLA in nature there are several restrictions: Sea temperature must be higher than 40^{0}C, special microorganisms must be available in soil, soil must have high humidity and low pH. Therefore, degradation rate of PLA is too low and there is a need for recycling [2]. PLA can be recycled chemically or mechanically. Mechanical recycle, while being easier and cheaper, decreases the mechanical properties of the PLA. Chemical recycle provides to obtain monomers and useful products. Main chemical routes for PLA recycle are hydrolysis, alcoholysis and pyrolysis. Use of valuable resources such as water and alcohol for the first two methods makes pyrolysis one of the leading methods for chemical recycle [3][4]. This research focused on the effect of nickel loaded silica aerogel catalyst on the degradation of poly(lactic acid) and product yields and distributions.

[1] Horizon (2023). Global Polylactic Acid Market Size & Outlook 2023-2030.

[2] Sivri, S., Dilek, Ç., & Sezgi, N. A. Polymer Engineering and Science, 65(8), 2025, 4262–4273

[3] McKeown, P., and Matthew D. J. Sustainable Chemistry, 1(1), 2020, 1–22

[4] Sivri, S., Sezgi, N. A., & Dilek, Ç. Journal of Supercritical Fluids, 217 (2025), 106473

[5] Richardson, J. D. Applied Catalysis A-General, 246(1), 2003, 137-150

[6] Sökmen U. P Pyrolysis of polylactic acid using bifunctional catalyst. M.S Thesis/METU, 2024

Math Without Barriers

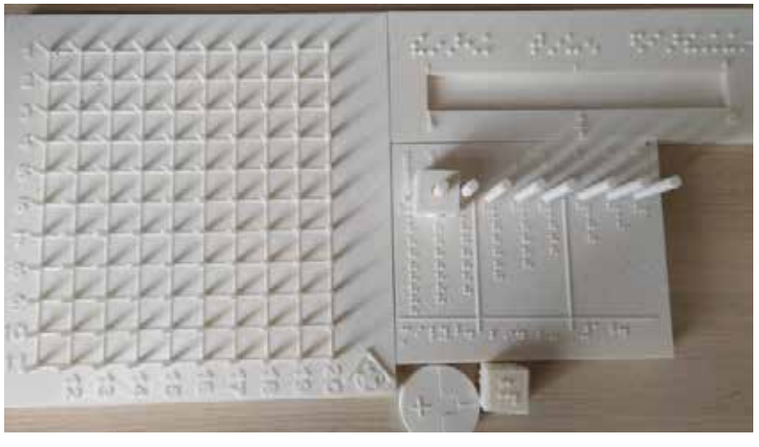
Research Area: Mathematics Education

Project Team Members: Özge İpek, Hamza Arıkan, Eray Taş, Zahide Ersoysal and Berru Köseoğlu

Project Supervisors: Inst.Dr. İpek Saralar

Abstract:

Mathematics Without Barriers is an inclusive digital learning platform developed to support visually impaired students in accessing mathematics education without limitations. The project provides fully narrated lessons, audio-based problem sets, and detailed audio instructions for using specially designed tactile manipulatives. All components are built within a screen-reader-compatible interface that promotes independent and meaningful engagement with mathematical concepts. Through user-centered design and iterative testing with visually impaired students, the project aims to improve conceptual understanding and reduce accessibility barriers. Early findings indicate that audio-supported materials significantly enhance students' ability to explore abstract ideas. The initiative ultimately seeks to support educational equity by making mathematics learning more intuitive, accessible, and barrier-free.

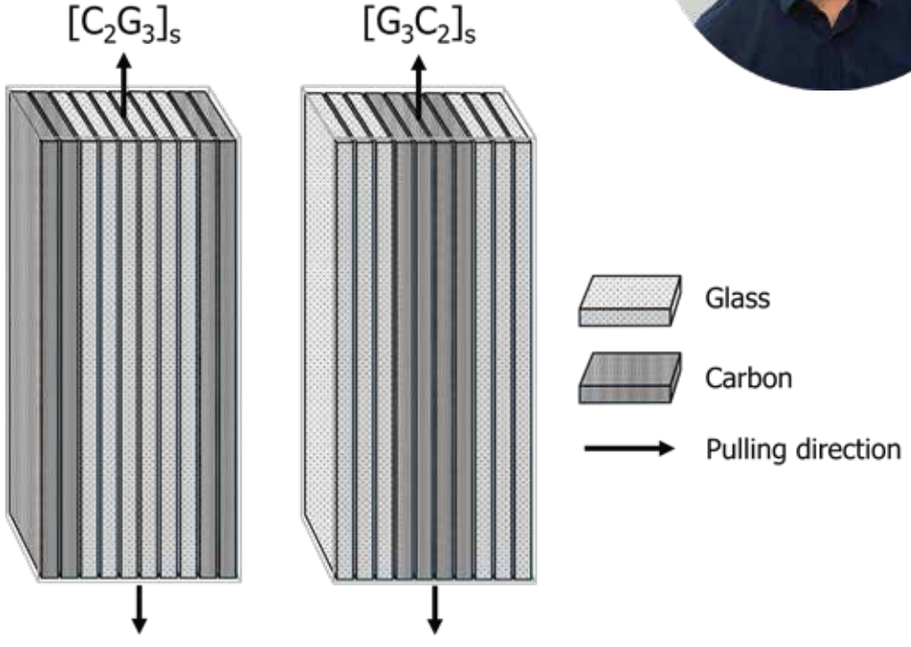


The Effect of Stacking Sequence on The Tensile Behaviour of Glass-Carbon Hybrid Composites

Research Area: Aerospace Engineering
Project Team Members: Tarık Kara
Project Supervisors: Prof. Demirkan Çöker

Abstract:

This study examines the tensile behavior of carbon/glass hybrid composite laminates manufactured through vacuum-assisted resin transfer molding (VARTM). Two symmetric hybrids consisting six glass (G) plies and four carbon (C) plies were produced: one with glass on the outer surfaces $[G_3C_2]s$, and another with carbon on the outside $[C_2G_3]s$. Baseline 10-ply carbon [C10] and 10-ply glass [G10] laminates were also tested for comparison. Placing the glass layers on the outside improved performance, while both hybrids showed the same failure pattern of fiber breakage and delamination regardless of stacking sequence.



Multi Sensor Fusion Box

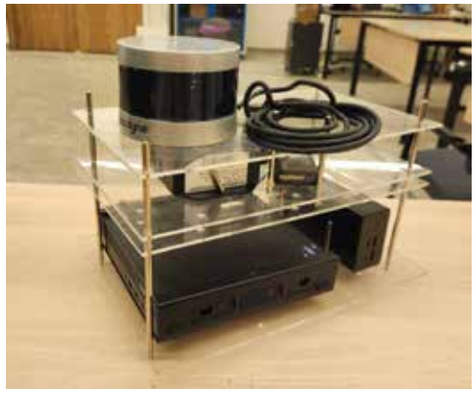
Research Area: Robotics and Control

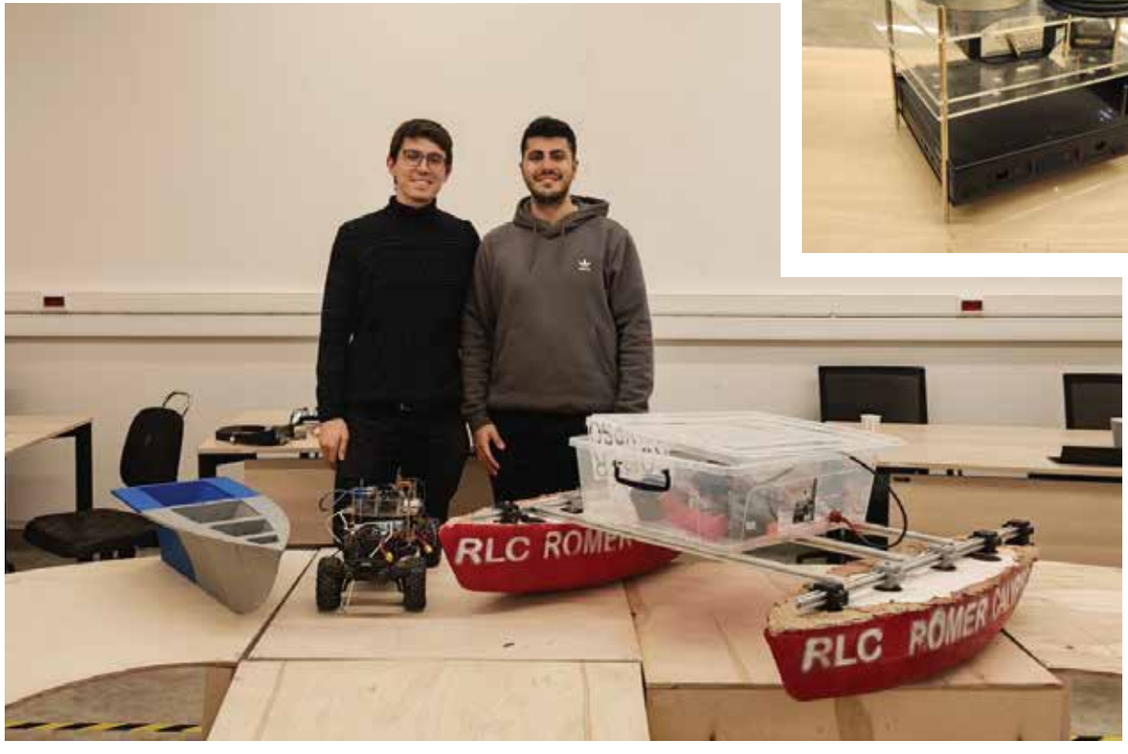
Project Team Members: Emirhan Yolcu and Efe Mert Oral

Project Supervisors: Assoc.Prof. Mustafa Mert Ankaralı, Res.Assist. Atakan Durmaz

Abstract:

This project presents the design and implementation of a modular Multi Sensor Fusion Box, aimed at generating extensive and diverse datasets for Visual-Inertial Odometry (VIO) and Simultaneous Localization and Mapping (SLAM) applications. Addressing the scarcity of comprehensive datasets across varying robotic scales, the proposed system integrates a suite of high-fidelity sensors, including Velodyne VLP-16 LiDAR, Stereo RGB-D cameras, IMU, and RTK-GPS modules, into a synchronized, portable unit. The core of the estimation framework utilizes the Multi-State Constraint Kalman Filter (MSC-KF) algorithm to perform real-time sensor fusion and accurate trajectory estimation. By enabling seamless data acquisition on diverse platforms—ranging from wheeled and legged robots to autonomous vehicles—this research provides a robust benchmark resource for validating and enhancing the robustness of next-generation robotic perception algorithms in dynamic and unstructured environments.





Experimental and Numerical Analysis of Phaseguides with Corner Radius

Research Area: Microfluidics
Project Team Members: Ayşe Ardıç and Seçkin Eroğlu
Project Supervisors: Assoc.Prof. Ender Yıldırım

Abstract:

Phaseguides are microscale ridge structures that utilizes capillary behavior of liquid to pin and steer liquids in microfluidic systems. They commonly used as stop/burst valves to regulate liquid advancement, enabling controlled sequential and bubble-free filling in lab-on-chip devices. In this study, we implemented a numerical and experimental approach to determine behavior of phaseguides with corner radii over a range of geometries. Building on these insights, we are developing an alternative route to chip manufacturing that exploits high-precision PCB milling to generate reproducible structures in polymer substrates. It has been observed that overflow pressure increased with corner radius peaking at 50 µm as sharp edge instabilities vanished, then declined as opposing meniscus ends started to interact with each other.

Green Hydrogen Production for Clean Energy Rimers

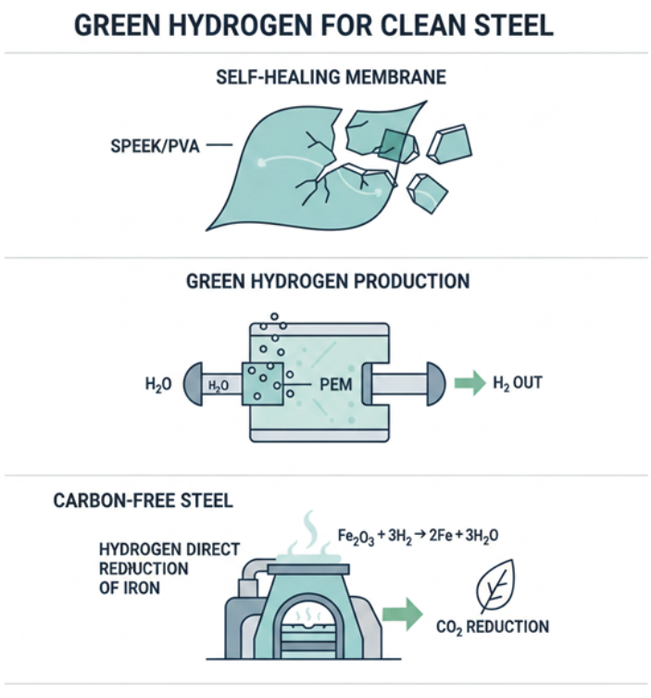
Research Area: Metallurgical and Materials Engineering

Project Team Members: Safiye Özge Öğüt, Berat Özbağ, Alper Soyer, Sezin İrem Şenses, Mustafa Tolga Tokucu, Can Tuncer and Oğuzhan Turgut

Project Supervisors: Assist.Prof. Çiğdem Toparlı

Abstract:

In order to potentially replace Nafion without compromising performance, we created a low-cost, self-healing SPEEK/PVA proton exchange membrane for PEM electrolyzers. Reversible hydrogen bonding between SPEEK and PVA provides mechanical reinforcement and allows self-supporting repair of microcracks and pinholes under humid operating conditions. PEEK was sulfonated to form SPEEK (verified by FTIR), blended with hydroxyl-rich PVA, and cast into a ~100 µm film. The membrane exhibits high water uptake and through plane proton conductivity on the order of ~10^{1} S cm^{1}, comparable to Nafion, while improved lifetime is expected from the self-healing network. Implemented in a 25 × 25 cm single-cell PEM electrolyzer, the produced hydrogen can be used for hydrogen direct reduction of iron ore (HDRI) followed by EAF steelmaking, supporting significant CO_2 emission reductions versus conventional coke-based routes.



Exploring Gamification use in Higher Education: METU Case

Research Area: Educational Sciences, Instructional Technologies, Methods of Instruction
Project Team Members: Alara Özaslan
Project Supervisors: Assoc.Prof. Nur Akkuş-Çakır

Abstract:

Gamification, defined as the application of game design elements in non-game contexts, is one of the most current approaches in higher education globally, including in Turkey. Since today's university students are members of Generation Z and Alpha, the education must adapt to their learning characteristics (Kovácsné Pusztai, 2021). This study was conducted as a case study to explore the use of the gamification as a teaching strategy in METU context. It focused on when, where and how the gamification was used and it examined its perceived effectiveness in higher education through interviews with instructors and students. The study provided insights into its impact on learning experiences and documented its use across faculties at METU.

Transforming Altıağaç: Impacts of Urban Transformation on Neighborhood Culture

Research Area: Political Science, Sociology, Urban Politics
Project Team Members: Burak Dirlik, Batuhan Kandemir and Mehmet Kağan Güney
Project Supervisors: Prof. Aylin Topal

Abstract:

Large-scale urban transformation projects that took place in Turkey within the last decades have been an important part of the urban policy of Turkey and have reshaped the lives of the residents in these projects took place in major ways. One of these major changes concerns changes within the culture and the way of living of the neighborhoods and small-scale communities in which urban transformation took place. This study examines the case of the neighborhood of Altıağaç, Mamak, a neighborhood that underwent a major change with an urban transformation project recently, to explore the changes in the neighborhood culture and way of living of the residents and the effects of these changes on the residents. This study aims to answer the questions of does urban transformation really causes the neighborhood culture to be destroyed or new cultures emerge in the newly established communities, how urban transformation projects cause neighborhood culture to be destroyed, and how the destruction of neighborhood culture affects residents' lives. This study also claims that urban transformation projects in Turkey, prioritizing economic growth over social aspects, dismantle neighborhood culture, weaken social links, and thus contribute to the reduction of social well-being of the residents, among other injustices, while using concepts such as gentrification, use value/ exchange value, and neighborhood culture to uncover the said injustices. The research utilizes qualitative methods, such as field observation and specifically semi-structured in-depth interviews, to uncover this phenomenon and the questions. Early field study supports the posed argument; however, further research with a planned larger sampling of interviewees is required for reliability.

Hybrid Play for Young Refugee Children

Research Area: Educational Sciences
Project Team Members: Işıl Eskier, Fatma Köle and Hilal Altunay Yılmaz
Project Supervisors: Prof. Yeşim Çapa Aydın

Abstract:

This project aims to develop a hybrid play–based method to support the social integration of Syrian refugee children aged 2–6 living in Türkiye. The process of forced migration causes language barriers, adaptation difficulties, and challenges in classroom social interaction, especially for young children in early childhood. In this context, the project seeks to design new hybrid games by combining the traditional games of Turkish and Syrian children, which share culturally similar elements. These drama-based games will provide a safer, more inclusive, and interactive learning environment where children can engage with their peers. During the method development process, semi-structured interviews will be conducted with experts and with the families of refugee children, and the data obtained will be used in game design. At the end of the project, the designed hybrid games will be shared through a website that preschool teachers and teacher candidates can easily access. The main motivation of the research is to support children's social-emotional needs through play, reduce their anxiety during the adaptation process, and minimize the obstacles caused by language differences. The project aims to increase children's opportunities for socialization while also providing teachers with a practical resource.

Cricket Protein Extraction via Deep Eutectic Solvent for Functional Instant Coffee

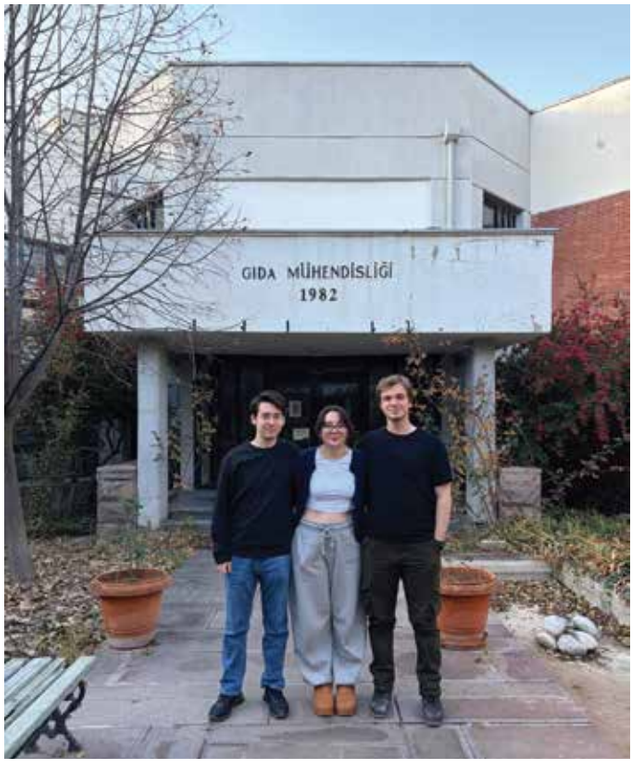
Research Area: Food Technology

Project Team Members: Alper Küçükhayrat, Dila Çınar, Furkan Kozak and Melis Çetin Karasu **(Mentor)**

Project Supervisors: Prof. Mecit Halil Öztop

Abstract:

Edible insects like house crickets (Acheta domesticus) are promising sustainable protein sources; however, the industry is transitioning towards novel green processing technologies. This study focuses on the extraction of proteins from defatted cricket powder using Deep Eutectic Solvents (DES) as an eco-friendly alternative to conventional alkaline methods. The primary objective was to evaluate the efficacy of DES in maximizing protein recovery yield while preserving functional properties. Furthermore, to demonstrate a practical application, the extracted cricket protein was incorporated into coffee to develop a protein-fortified functional beverage. The study investigates both the extraction efficiency of the green solvents and the feasibility of introducing insect-based protein into a daily consumer product. The findings highlight the potential of DES for sustainable protein recovery and showcase the innovative use of cricket protein in coffee, paving the way for the development of novel, eco-friendly functional foods.



Non-Destructive Testing of Composite Rocket Insulator Material by THz-TDS Spectroscopy

Research Area: Non-Destructive Testing
Project Team Members: İrem Türker
Project Supervisors: Prof. Okan Esentürk

Abstract:

Composite insulation materials used in solid rocket motors experience performance loss when internal defects such as delamination occur. Terahertz Time-Linear Spectroscopy (THz-TDS) non-destructively analyzes these materials, precisely revealing changes in refractive index and absorption behavior. In this study, internal delaminations of four different sizes in a composite insulation sample were detected using THz-TDS, and the material's absorbance was examined. The findings demonstrate that THz-TDS is a reliable assessment tool for composite insulation structures. Furthermore, the method provides high sensitivity to early-stage or near-surface defects. Overall, the study demonstrates that THz-based non-destructive inspection is an effective and successful approach for these types of materials.

Fanship Scale Turkish Sample Adaptation Study

Research Area: Social Psychology
Project Team Members: İrem Ayar, Öykü Kaya and Tebessüm Hatice Gümüş
Project Supervisors: Assoc.Prof. Banu Cingöz Ulu

Abstract:

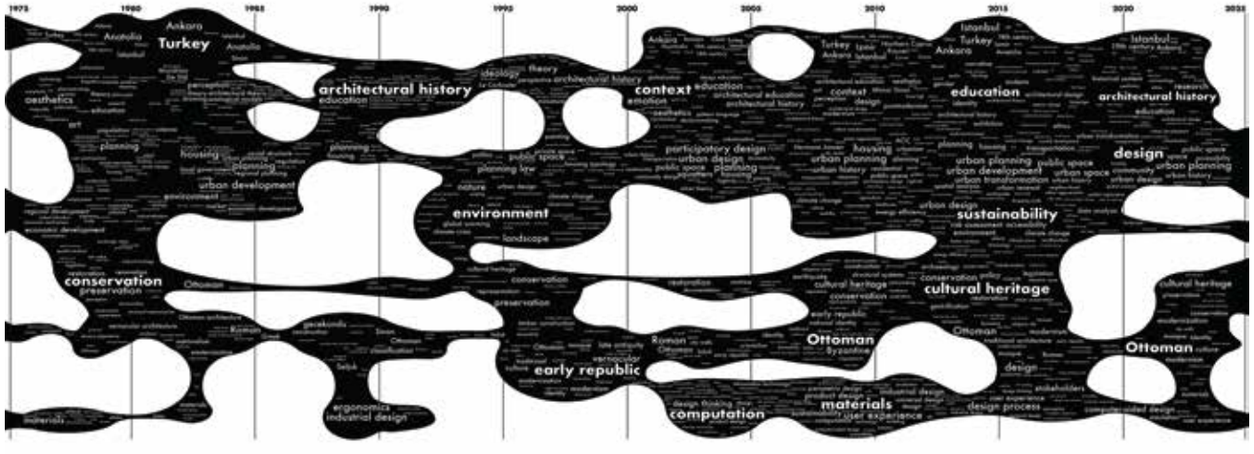
This study aims to adapt the Fanship Scale, developed by Reysen and Branscombe (2010), for use in Turkish to support fan research in Türkiye. "Fanship" refers to the bond people feel towards the person or fiction they are a fan of. In the current study conducted with 240 fans, it was seen that internal consistency reliability was quite acceptable (α=.86). The factor analyses supported the one-dimensional scale structure, and the factor loadings of all items were found to be sufficient. According to the validity analyses, the adapted scale showed a significant correlation with the Passion Scale (Kelecek & Aşçı, 2013; Vallerand et al., 2003), used to measure convergent validity, confirming the hypothesis. The scale also showed a significant correlation with the Social Desirability Scale (Erzen et al., 2021) used to measure divergent validity. When considered as a whole, the results show that the Turkish version of the Fanship Scale is a reliable and valid tool that measures the fanship levels of different fan groups.

Mapping the Knowledge Production: 50 Years of the METU Journal of the Faculty of Architecture

Research Area: Digital Humanities
Project Team Members: Deniz Ak, Ömür Buğra Gündüz and Şule Çekmegeli
Project Supervisors: Assoc.Prof. Pelin Yoncacı Arslan

Abstract:

As part of the META JFA, 50 Years of the METU Journal of the Faculty of Architecture (METU JFA) Exhibition, we as a team contributed to the exhibit by creating various visualizations through our analysis of content and history of the journal. The journal, we discover, is not merely a repository of knowledge but an active cartographic project that has continually redrawn the boundaries of our fields. Yet in making these maps, we take possession of and literally define an interface: we name features, reveal relationships, indicate boundaries, and mark unknown regions for exploration. What you encounter is simultaneously familiar and disorienting—a terrain inhabited for half a century yet only now apprehensible as a totality.



Simulation of Human Communication with Persona-Based LLM Agents: Evaluating Behavioral Fidelity in Social Media Discussion Threads

Research Area: Large Language Models (LLM)
Project Team Members: İsa Adahan Ünal and Zeynep Sude Yılmaz
Project Supervisors: Assist.Prof. Çağrı Toraman

Abstract:

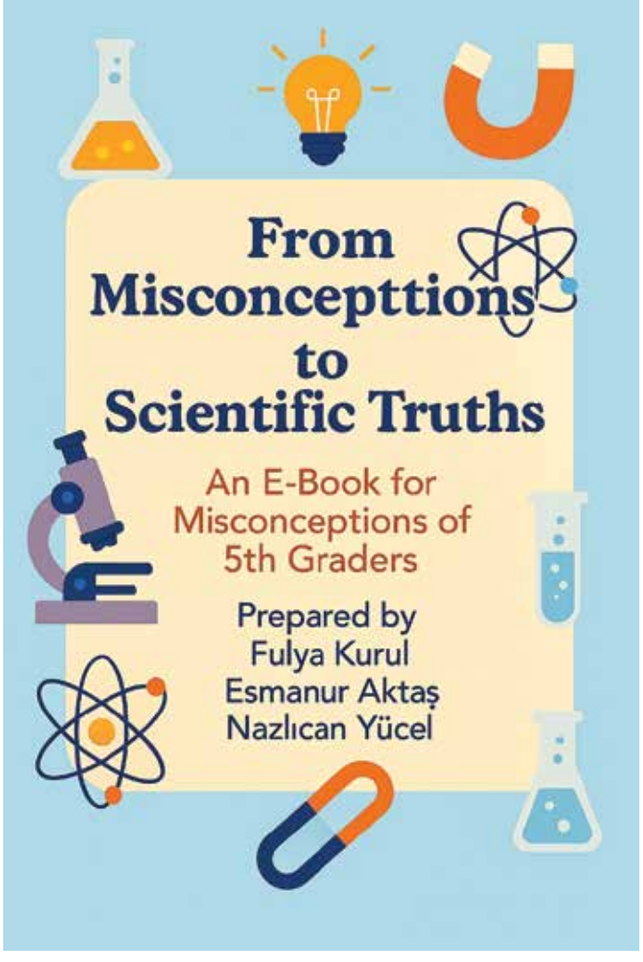
This study examines how effectively large language model (LLM) agents can simulate real social media interactions. For each participant in a Bluesky discussion thread, a thread-local persona is generated using only that user's comments, capturing local writing style and conversational behavior. Each persona is assigned to a corresponding LLM agent, establishing a one-to-one mapping between agents and real users. The original discussion structure and reply order are preserved during simulation. Agent-generated responses are evaluated against original human comments using semantic similarity metrics and an LLM-as-a-judge approach.

From Misconceptions to Scientific Truths: An E-Book Project for 5th Grade Students

Research Area: Science Education
Project Team Members: Fulya Kurul, Esmanur Aktaş and Nazlıcan Yücel
Project Supervisors: Asst. Prof. Engin Karahan

Abstract:

The aim of this project is to create an interactive e-book that will dispel prevalent misconceptions about scientific education in the fifth grade. The study uses instructional techniques like cognitive dissonance, refutation texts, and activity-based learning and is grounded in constructivist learning theory. The e-book is enhanced with digital resources, including as simulations, animations, and tools powered by artificial intelligence, and it is in line with the 2024 Science Curriculum. According to preliminary findings, misconception-oriented exercises can improve students' conceptual comprehension and interest in science subjects. The finished e-book is meant to be a useful and approachable tool for science instructors and students alike.

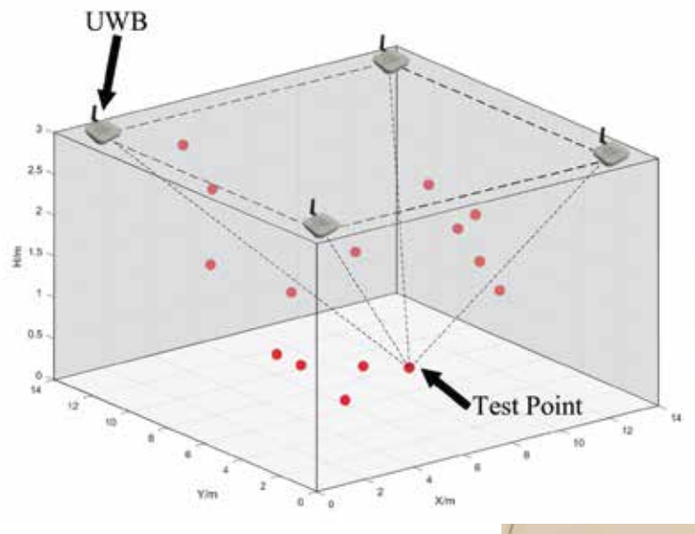


Tracking Everything, Everywhere, All at Once

Research Area: Robotics
Project Team Members: Haktan Bayram Koyuncu, Emirhan Yolcu and Mehmet Güner
Project Supervisors: Assoc. Prof. Mustafa Mert Ankaralı and Res.Assist. Atakan Durmaz

Abstract:

This project aims to develop a real-time, portable, and high-accuracy indoor localization system for robots and autonomous systems operating in GPS-denied environments where visual methods often fail due to lighting or occlusions. The methodology utilizes Ultra-Wideband (UWB) technology for high-resolution ranging, integrating these measurements with Inertial Measurement Unit (IMU) data through Extended or Unscented Kalman Filters (EKF/UKF) to enhance robustness against noise and signal dropouts. To further address environmental challenges such as Non-Line-of-Sight (NLOS) conditions and multipath reflections, the system incorporates a reinforcement-learning-based correction layer that adapts to changing surroundings. Validated against a ground truth motion capture system, this approach achieves precise tracking with stationary positional errors of less than 5 cm and dynamic errors under 40 cm.



Multi-Sensor Acoustic Localization System for Detecting Trapped Victims in Disaster Zones

Research Area: Acoustics Engineering and Signal Processing
Project Team Members: Zain ElAbdeen AlDwai, Tuana Arat, Amine Güneş and Nazlıcan Yıldırım
Project Supervisors: Prof. Alpan Bek and MSc. İmre Özbay

Abstract:

Simulation results detecting disaster victims in tight spaces with limited air paths, is a crucial step for all search and rescue operations. Acoustic amplifier units used during search and rescue operations respond to loud ambient sound, which is excessive in disaster zones. We developed a multi-sensor acoustic signal fusion hardware and software, for localizing victims and amplifying faint sound signals. To improve performance metrics (like noise immunity, obstacle tolerance, and so on) we evaluated the positive contribution from our proposed improvement: impact of signal processing techniques, geometry and pure mathematics, sensor hardware technology selection.

Road to Campus: Challenges and Experiences of METU Students in Public Transportation

Research Area: Social Sciences
Project Team Members: İlyas Kayra Ak, Doruk Akyol and Umut Göçmen
Project Supervisors: Prof. Mustafa Kemal Bayırbağ

Abstract:

The study explores the daily public transport experiences of Middle East Technical University (METU) students in Ankara, focusing on the costs, constraints, and inequalities embedded in their commutes. It examines how students plan their routes to and from campus, the structural and subjective difficulties they face, and how they shape their temporal, psychological, economic, and social well-being. Using a mixed-methods design that combines a student survey and semi-structured in-depth interviews, the project analyzes key issues such as accessibility barriers, time-budget pressures, perceived safety, alternative and informal mobility strategies (e.g. car sharing, hitchhiking), night-time travel, and gender-based safety concerns. The findings aim to reveal how structural public transport deficiencies and social inequalities intersect to shape student mobility, and to translate these insights into policy-relevant recommendations for METU and municipal actors to improve students' everyday transportation experience in Ankara.

DEĞİŞKENLER (Variables)	Cinsiyet (Gender)	Gelir (Income)	Okula Yakınlık	Araç Sahipliği	Fakülte (Faculty)
Cinsiyet (Gender)	--- N/A				
Gelir (Income)		--- N/A			
Okula Yakınlık (Proximity)			--- N/A		
Araç Sahipliği (Vehicle Own.)				--- N/A	
Fakülte (Faculty)					--- N/A

Moonwalker: Lunar Rover VR & Solar Navigation & Exploration

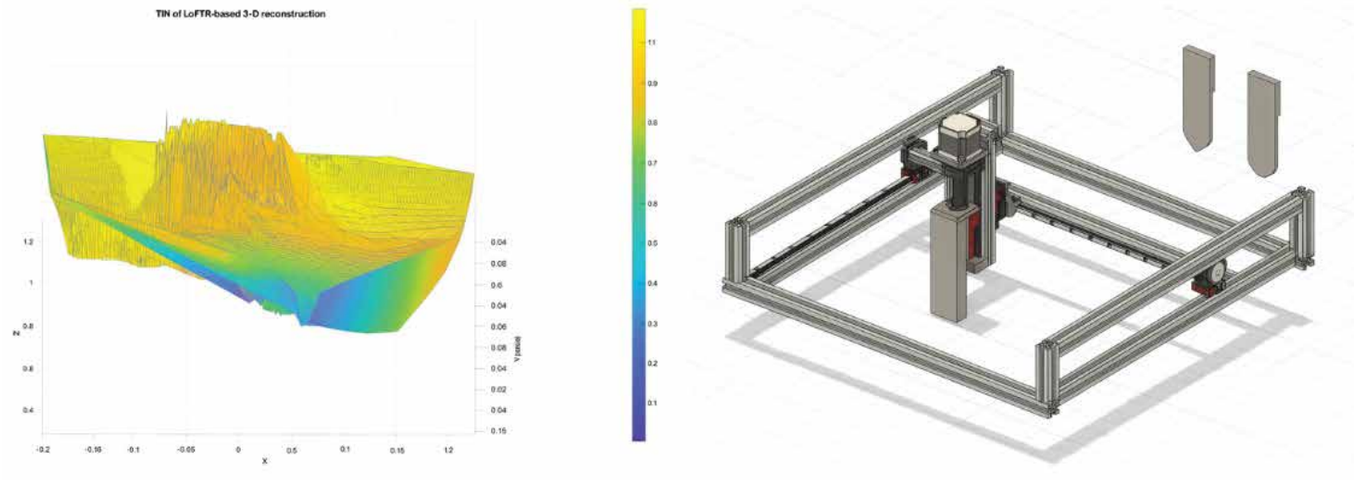
Research Area: Planetary Surface Modeling and Ground-Based Test Systems

Project Team Members: Eren Okur, Özgün Öncül Öz, Ege Mert Balçık, Ömürhan Kurt, Hüseyin Batuhan Yıldırım and Eda Bülbül

Project Supervisors: Assoc.Prof. Halil Ersin Söken, Res.Assist.Atakan Durmaz

Abstract:

This project aims to generate a realistic three-dimensional (3D) model of the lunar surface and reproduce this terrain within a physical test environment. In the first phase, thousands of images acquired from past and current lunar missions are processed using Structure-from-Motion and robust feature matching methods to create a detailed digital map. This model incorporates fundamental surface geometries such as craters, slopes, and elevation changes. The generated digital terrain is converted into toolpaths and physically produced using a custom sand shaping system capable of shaping the surface layer by layer. Following the shaping process, the terrain is scanned.

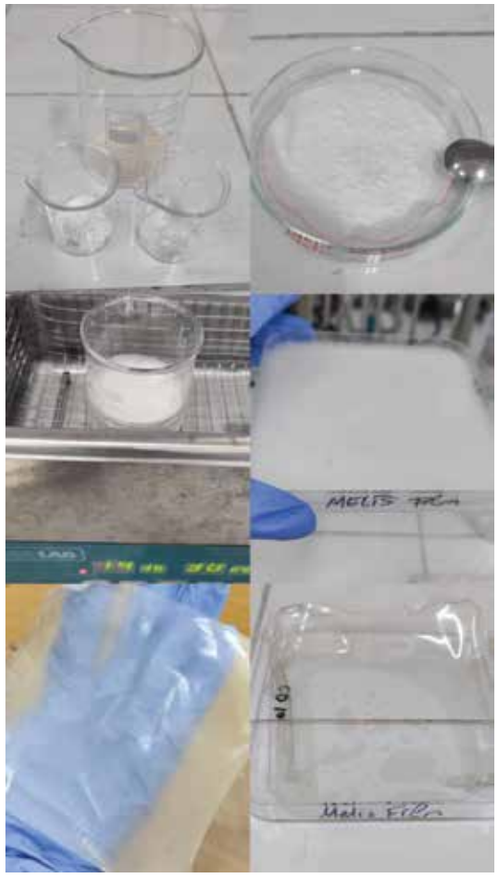


Encapsulation of Pine Turpentine Oil for Active Food Packaging Film Development

Research Area: Active Food Packaging
Project Team Members: Hülya Melis Kara
Project Supervisors: Assoc.Prof. Leyla Nesrin Kahyaoğlu

Abstract:

Active packaging methods, incorporating essential oils (EOs) as an active component, offer a promising alternative to chemically synthetized additives in food packaging. These active food packaging systems are linked to biodegradable films and other edible films. In this project, Pine Turpentine Oil (PTO), a volatile plant-derived essential oil with potential antimicrobial and antioxidant properties, was investigated for incorporation into an active food packaging system. To ensure the stability and controlled release of the oil, it was encapsulated using β-cyclodextrin through emulsification. To create biodegradable films, the resulting inclusion complexes were further included into film-forming solutions based on pectin. The project explores the use of encapsulated pine turpentine oil as a functional additive in biopolymer-based packaging films, aiming to develop active food packaging.

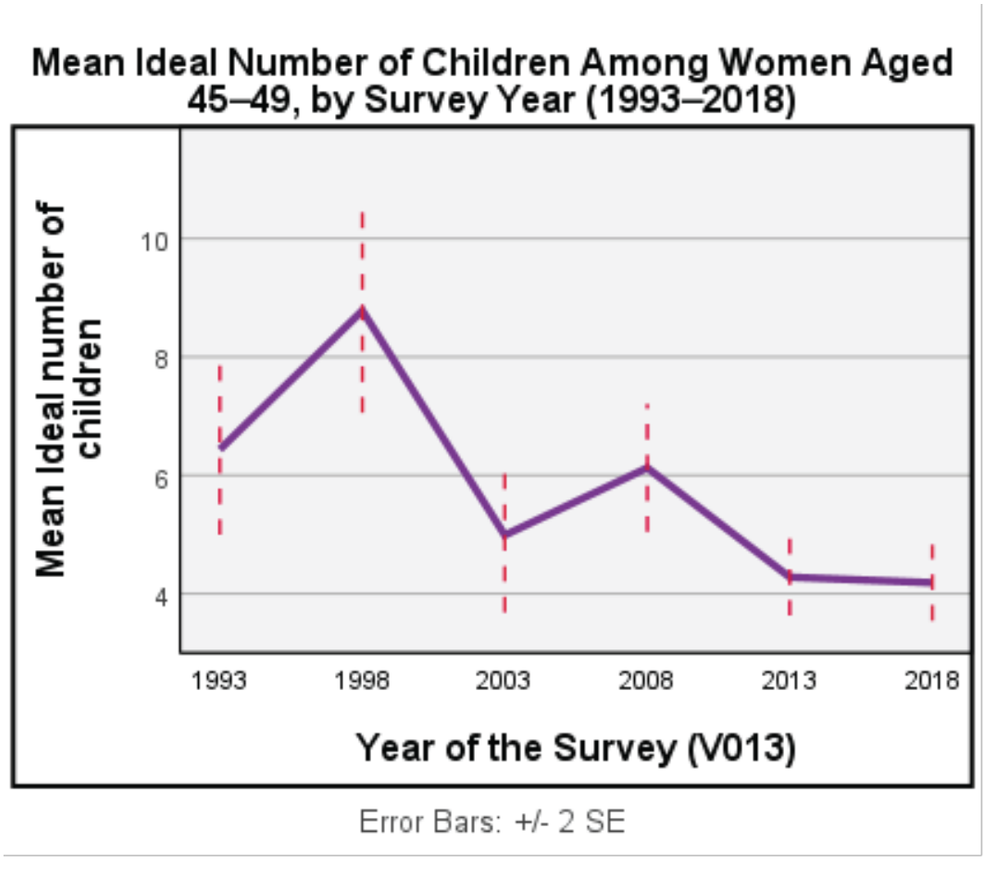


Fertility Trends in Turkey: The Impact of Socio-Economic and Cultural Factors on Fertility Change

Research Area: Social and Economic Sciences
Project Team Members: Elif Sinem Özel
Project Supervisors: Assoc.Prof. İlhan Can Özen

Abstract:

Through the analyses of Turkey Demographic and Health Survey's (TDHS) six datasets (1993-2018), this research examines the fertility outcomes and preferences with socio-economic and cultural control variables such as education, household structure, wealth, region, and intergenerational differences. As preliminary descriptive findings, this research showcases the continuous decline of fertility preference and the factors behind it. It focuses on how there appear to be differences in the gap between fertility preferences and outcomes of men and women. The research helps explain the reasons for the widening gap between the fertility preference and fertility outcome with the changes between 1993-2018 and depicts how intergenerational differences play a role.

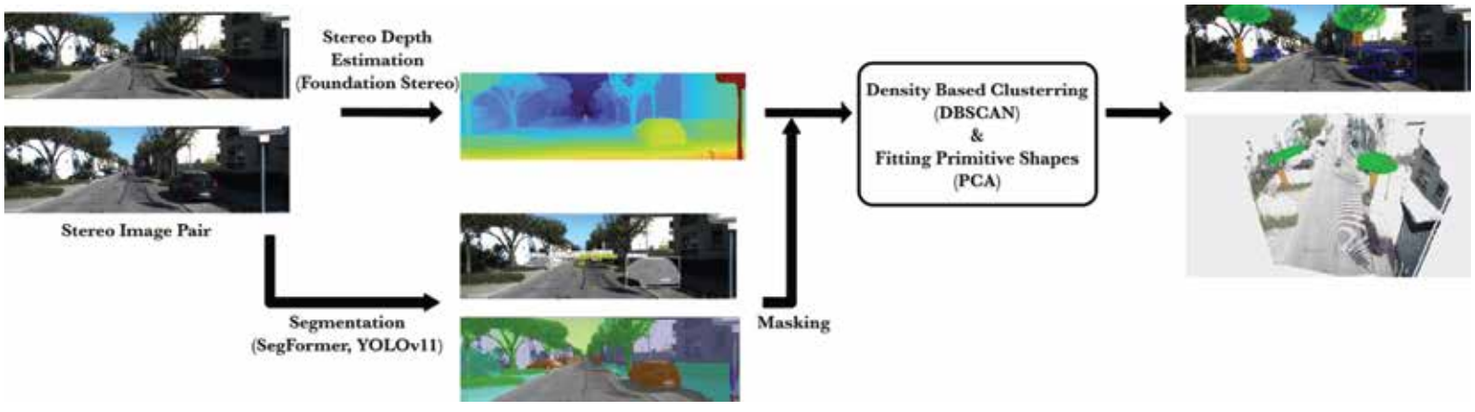


Automatic LIDAR Point Cloud Labeling Using Stereo Vision and Object Detection

Research Area: Machine Vision
Project Team Members: Erol Develi and Ecenaz Aslan
Project Supervisors: Assoc.Prof. Mustafa Mert Ankaralı, Res.Assist. Atakan Durmaz

Abstract:

Manual labeling of 3D LiDAR point cloud data, which is critical for autonomous driving systems and robotic applications, is a slow, costly, and error-prone process. This project presents a scalable method to automate this process by combining stereo vision and object detection techniques. In this study, depth maps derived from stereo images are geometrically aligned with LiDAR data, and 2D object detections (YOLO/SegFormer) identified in the images are projected into 3D space. Subsequently, automatic and precise 3D labeling of objects is achieved through the application of density-based clustering (DBSCAN) and shape-fitting (PCA) algorithms. This system facilitates the rapid generation of large-scale, labeled datasets necessary for training deep learning models.

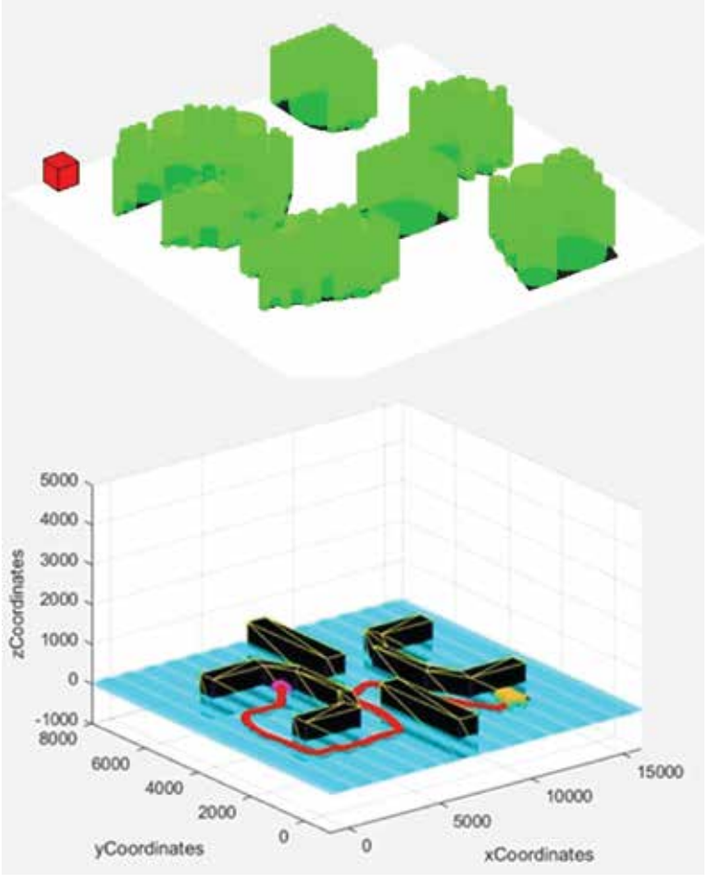


LIDAR GATE: Streaming Reality into Unity

Research Area: Robotics
Project Team Members: Elif Ahsen Soylu and Erol Develi
Project Supervisors: Assoc.Prof. Mustafa Mert Ankaralı, Res.Assist. Atakan Durmaz

Abstract:

LIDAR GATE is a project developed by METU Electrical-Electronics Engineering students to bridge raw LiDAR point clouds and actionable data for real-time navigation and simulation. The core motivation is the need for fast, interpretable LiDAR classification to enable real-time geometric understanding of environments. Our methodology involves collecting and classifying LiDAR data using geometric feature extraction, including covariance and eigenvalue analysis, to categorize structures as walls (2D spread) or poles (1D concentration). The system achieves high computational efficiency by sparsifying and streaming the classified point cloud data into the Unity game engine with minimal latency. This enables effective obstacle-aware motion planning and is ideal for lightweight transmission in autonomous navigation and environmental monitoring applications.

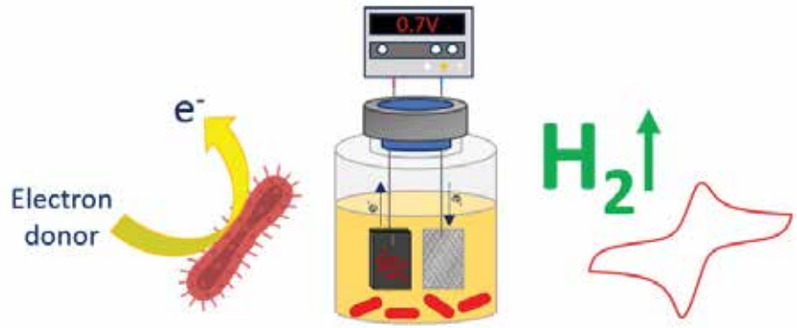


Investigation of the Exoelectrogenic Abilities of an Extremophilic Fermentative Bacterium

Research Area: Bioelectrochemistry
Project Team Members: Raushan Kunayeva and Idilay Konar
Project Supervisors: Assoc. Prof. Yasemin Dilşad Yılmazel Tokel

Abstract:

This study investigated whether a fermentative microorganism is capable of transferring electrons outside the cell to a solid electrode surface, a behaviour known as the exoelectrogenic activity. The organism was observed in a bioelectrochemical system operated under anaerobic conditions at 80C and quantification of the electron flow from the anode was used as an indicator of electron transfer activity. The results revealed consistent electron flow to anode associated with microbial activity, demonstrating that the fermentative organism can release electrons to the electrode surface. In parallel, hydrogen gas production was monitored to assess system operation under applied potential of 0.7V. This work provides clear evidence of extracellular electron transfer in a fermentative microorganism and establishes a foundation for future studies exploring the relationship between fermentative metabolism and bioelectrochemical systems.

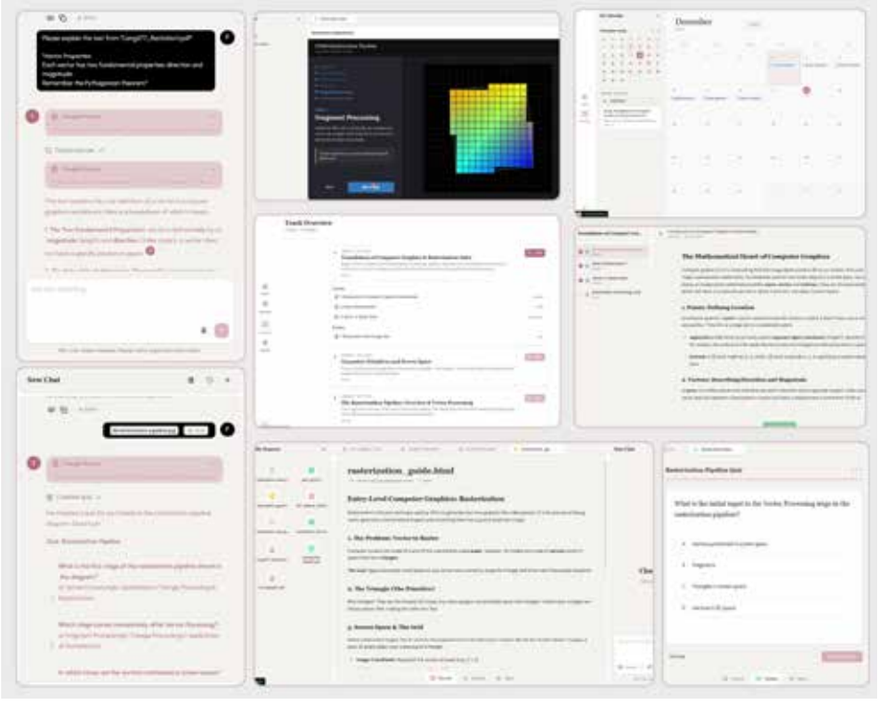


The Future of Learning (INKY): AI Agents as All-in-One Educational Ecosystem

Research Area: Artificial Intelligence
Project Team Members: Fadi Mohamed and Rayan Kriewah
Project Supervisors: Instructor Dr. Ayşenur Birtürk

Abstract:

INKY is an AI-driven learning platform that transforms ordinary educational sources into dynamic, interactive, and enjoyable learning experiences. Using Retrieval-Augmented Generation (RAG), multimodal content generation, and autonomous agents, the system converts documents, videos, and web pages into lessons, quizzes, activities, and creative study aids. Users, students and educators alike, organize their materials into Libraries, and the platform transforms them into structured Tracks, complete with lessons, schedules, and practice plans. A personalized memory and context system adapt learning paths to each user's history, preferences, and progress. The platform aims to reduce cognitive load while elevating engagement, accessibility, and personalizing pathways for every student and educator.

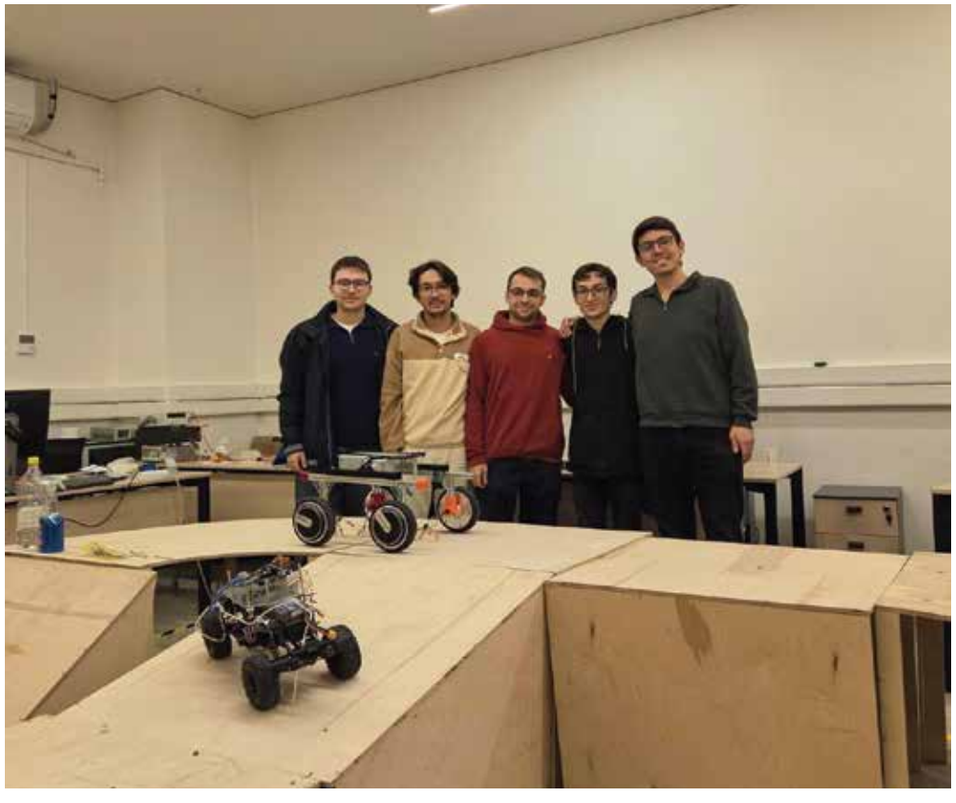


Adaptive Path Planning and Dynamic Obstacle Avoidance for Unmanned Ground Vehicles

Research Area: Electrical and Electronics Engineering
Project Team Members: Haktan Bayram Koyuncu, Efe Hepgenç, Efe Mert Oral and Lezgin Alimoğlu
Project Supervisors: Assoc.Prof. Mustafa Mert Ankaralı, Res.Assist. Atakan Durmaz

Abstract:

This project presents a novel, robust motion planning and control framework for Unmanned Ground Vehicles (UGVs) navigating complex 2D environments populated with both static and dynamic obstacles. To address the limitations of traditional algorithms designed primarily for stationary settings, the proposed method integrates a three-phase approach: first, constructing collision-free paths using funnel-based Rapidly-exploring Random Trees (RRT) for static environments; second, employing an Interacting Multiple Model (IMM) Kalman Filter to forecast dynamic obstacle trajectories and generate virtual avoidance zones; and third, utilizing a potential field algorithm to guide the vehicle toward its goal while mitigating local minima issues. The framework is validated through comprehensive simulations and real-time physical implementation on a custom dual-UGV experimental setup, demonstrating significant improvements in adaptability, computational efficiency, and safety for autonomous operations in unpredictable scenarios such as search and rescue or industrial automation.



Identifying Gaps in the Implementation of METU's Internationalization Policy: Reflections from International and Erasmus Students

Research Area: Internationalization Policy
Project Team Members: Nusrut Binte Motaleb Raka and Anusha Rashnu Rahman
Project Supervisors: Assoc.Prof. Asuman Göksel

Abstract:

As globalization drives the demand for overseas education, Turkey is reshaping its higher education system by integrating internationalisation policies into its framework to attract both International and Erasmus students. This study explores METU's implementation of institutional strategies designed to support non-native students across academic, administrative, and social welfare domains. Through a careful examination of aid infrastructures and student experiences, this research assesses the perceived impact of existing support systems in providing initial guidance, social integration opportunities, and academic assistance. A mixed-methods approach, which combines qualitative and quantitative methods to enrich data collection, will be used, including semi-structured interviews and questionnaire surveys. Additionally, a comparative aspect examines differences in regulations and support services for International and Erasmus students. Ultimately, identifying the gaps in METU's internationalisation policy, reflected through student perspectives, could enhance policy execution and expand the university's international outreach.

Less Emission, More Efficiency

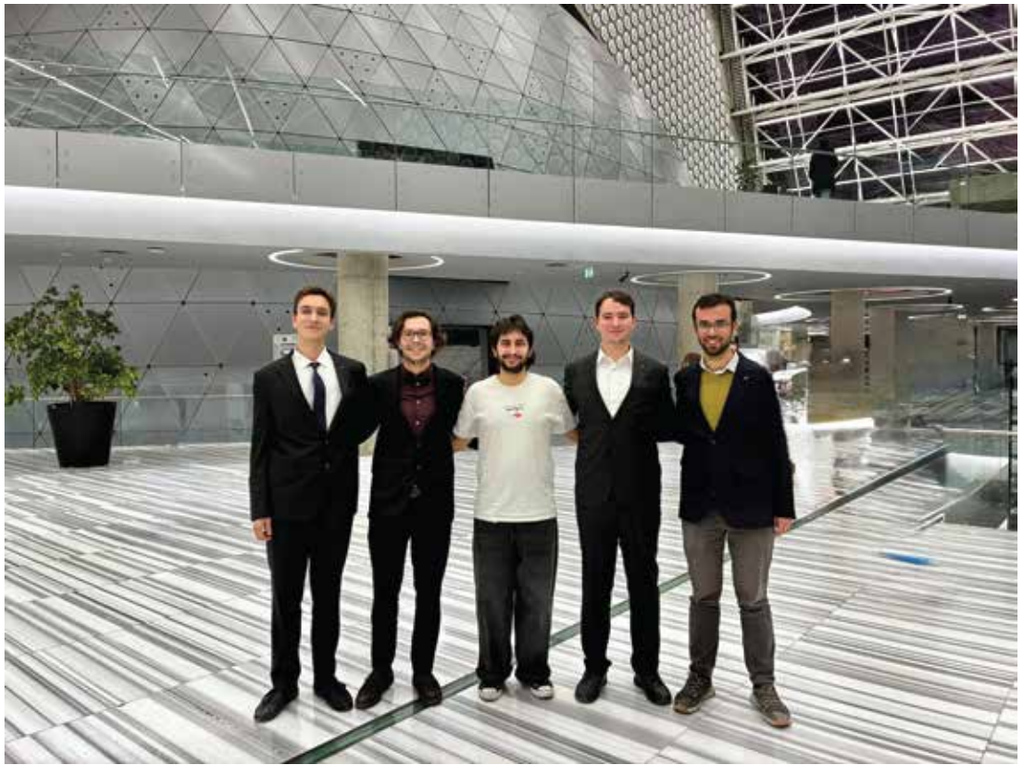
Research Area: Urban Mobility

Project Team Members: Ömer Faruk Altan, Şevket Yahya Akkaya, Ege Yiğit Şen, Güney Aart Verheij and Samet Yüksel

Project Supervisors: Prof. Hediye Tüydeş Yaman

Abstract:

This project critically examines the transportation dynamics between the Middle East Technical University (METU) Campus and the expanding urban fabric of Ankara. Adopting a holistic, data-driven approach, the study synthesizes quantitative traffic flow data with feedback obtained through comprehensive surveys of the METU community. This methodology allows for a rigorous evaluation of the current public transportation system regarding its demand-response capacity, accessibility, and overall operational efficiency. Building upon these analyses, the project identifies critical bottlenecks and connectivity gaps within the existing network to develop concrete proposals for route optimization and system integration. The ultimate objective is to establish a faster, more comfortable, and reliable access network for students and staff. Furthermore, by enhancing the appeal of public transit, we aim to minimize reliance on private vehicles, thereby significantly reducing the campus's carbon footprint and actively contributing to the sustainable goals of METU.



Maximization of Biohydrogen Production in Microbial Electrolysis Cells Through Electrode Material Comparison

Research Area: Biohydrogen Production, Sustainability, Conductive Materials

Project Team Members: İrem Bulat, Raushan Kunayeva and İdilay Konar

Project Supervisors: Assoc. Prof. Yasemin Dilşad Yılmazel Tokel

Abstract:

Hydrogen is considered a key energy carrier, but its production is still largely dependent on fossil fuels, contributing to greenhouse gas emissions. Microbial electrolysis cells (MECs) provide an environmental-friendly and sustainable alternative by utilizing electro-active microorganisms for biohydrogen production. Despite its high potential, cell densities are low in MECs, which limits hydrogen production. To overcome this, conductive materials with large surface areas are added, providing attachment sites and increasing cell density. This process is called bacterial immobilization. This study shows immobilization of a hydrogen producer. This study also compares carbon fiber brushes and graphite plates in MECs, focusing on biofilm formation, current generation, and hydrogen production. Carbon fiber brushes occupy more volume in the reactor than graphite plates, but they provide a higher surface area, which can enhance biofilm growth and, consequently, current generation and biohydrogen production. To improve performance, jacketed glass reactors are designed and utilized as MECs.

Inclinometer

Research Area: GPS-GNSS Free Positioning Technologies

Project Team Members: Emre Özdoğan, Umut Keleş, Mevlüt Akçakuyu, Ömer Faruk Hadık and Ömer Faruk Şanlıer

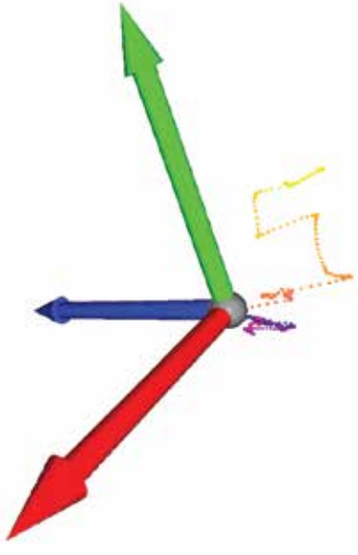
Project Supervisors: Prof. Haluk Külah

Abstract:

The Inclinometer Project originates from the problems of communication and positioning faults in skiing in bad weather conditions in the mountains. Furthermore, it is seen that the same problem occurs in military operations and natural disaster scenarios. The positioning of the individuals becomes significant in these conditions. Inclinometer mainly focuses on natural disasters. Although no GPS signal could be achieved during disasters, this Project uses pure environmental data. Using an IMU (Inertial Measurement Unit), the device gathers acceleration and magnetization information. In general practice, two IMU's are used to reduce drift (error accumulation). Inclinometer is focused on possible and more reliable solutions for the second IMU. An Optical Flow LIDAR Sensor is used to reduce drift in this project. A real-time Kalman Filter is implemented to fusion sensors. The Optical Flow LIDAR Sensor provides velocity information at three axes, which is used to correct the IMU and possibly reduce the error accumulation further.





Bio-Inspired Design and Fabrication of Bi-material Hierarchical Interfaces

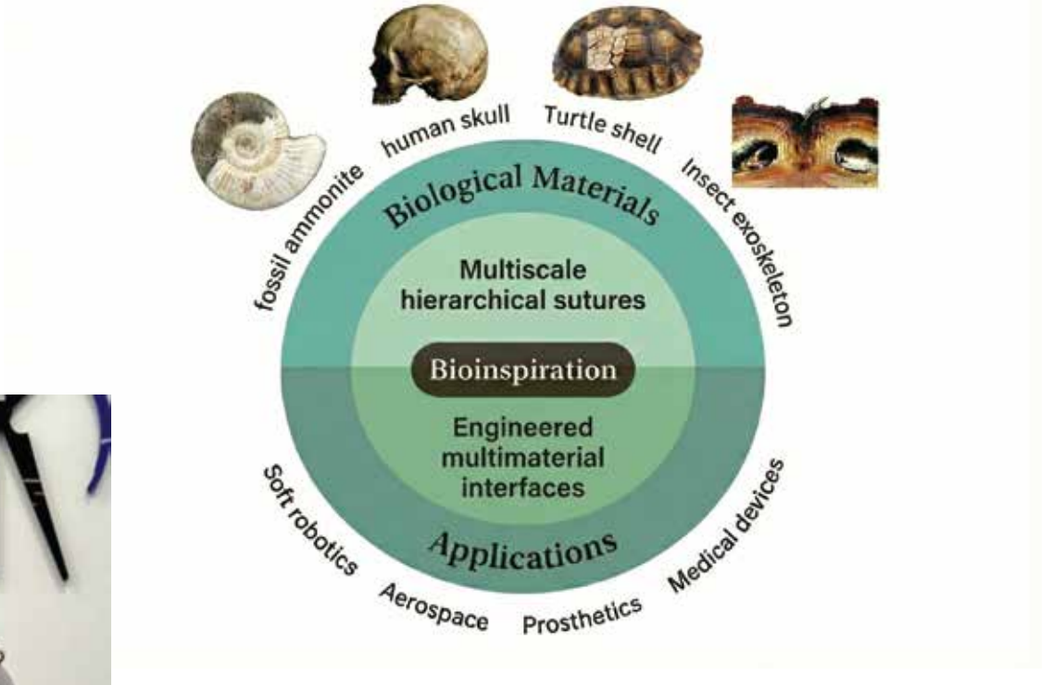
Research Area: Aerospace, Solid mechanics, Fracture Mechanics

Project Team Members: Ansel Z. Kayar and Denizhan Yavaş

Project Supervisors: Prof. Demirkan Çöker

Abstract:

This study develops a secondary level hierarchical interface that improves joining between soft and rigid materials. A triangular geometry was designed and produced using multi-material additive manufacturing, allowing controlled interlocking at different scales. Pull tests and image-based deformation analysis show that the hierarchical interface spreads load more uniformly and delays failure compared to a flat reference. These results demonstrate that geometry-driven design can enhance interface performance and support systems requiring soft/rigid interface applications.



Calypso

Research Area: Autonomous surface vehicles (USVs), multi-sensor fusion, real-time control algorithms, and modular catamaran architecture

Project Team Members: Hacer Ayça Yılmaz, Emirhan Yolcu, Erol Develi, Efe Hepgenç, Kemal Jack Erten, Efe Mert Oral, Haktan Bayram Koyuncu, Mehmet Güner, Volkan Taştan, Lezgin Alimoğlu, Bora Gençer, Mertcan Gençdal, Ece Naz Aslan and Ahsen Soylu

Project Supervisors: Assoc.Prof. Mustafa Mert Ankaralı and Res.Assist.Atakan Durmaz

Abstract:

The Calypso project aims to develop a fully autonomous, modular-sensor, twin-hull (catamaran) unmanned surface vehicle (USV). The platform integrates multiple sensors—such as LiDAR, stereo cameras, IMU, and GNSS—into a single real-time data pipeline to enable high-accuracy perception and localization. Instead of using a commercial autopilot, the control architecture is kept fully customizable and transparent. Through in-house, real-time algorithms, the system offers mission-oriented performance, agile maneuverability, and a flexible structure suitable for research purposes. Within the scope of the project, advanced studies are targeted, including learning-based adaptive control, robust maneuvering under uncertain dynamics, advanced perception, and rich sensor fusion. With these capabilities, Calypso serves as a powerful test platform for academic research and the development of autonomous systems.

Wastewater Treatment Performance by Lemna Gibba

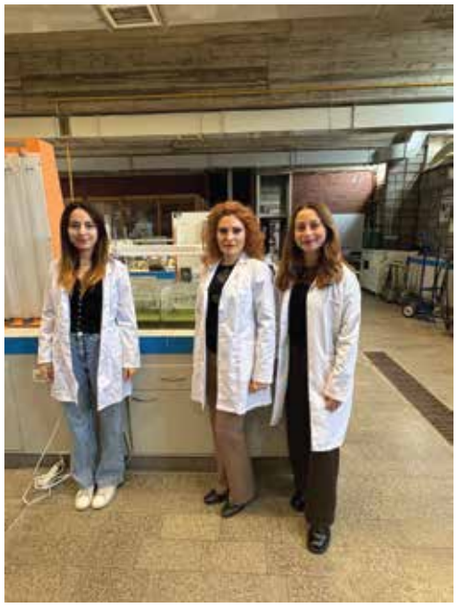
Research Area: Wastewater treatment, Nature-Based Solutions

Project Team Members: Berre Şengül and Yaren Özmen

Project Supervisors: Asst. Prof. Sema Sevinç Şengör

Abstract:

Excess nutrient and organic matter discharges from wastewater treatment plants (WWTPs) contribute to eutrophication in receiving water bodies. Nature-based systems offer energy-efficient alternatives to enhance nutrient removal. Duckweed is a small, free-floating aquatic plant from the Lemnaceae family that has been extensively studied for treating various waste streams, including domestic sewage, dairy lagoons, and secondary effluents. Our study investigated the short-term treatment performance of duckweed (Lemna gibba) using secondary sedimentation effluent from the Ankara Tatlar WWTP. Experiments were conducted for one week under controlled light–dark conditions (16h☀:8h⬤) in laboratory-scale reactors. Removal efficiencies for phosphate (PO_4-P), ammonia nitrogen (NH_3-N), nitrate nitrogen (NO_3-N), total nitrogen (TN), and chemical oxygen demand (COD) were determined. Results indicated effective reduction of nitrogen and organic matter, supporting the potential of duckweed as a polishing step in existing wastewater treatment schemes.



The Power Matrix: Quantifying Strategic Motives Beyond the DPT

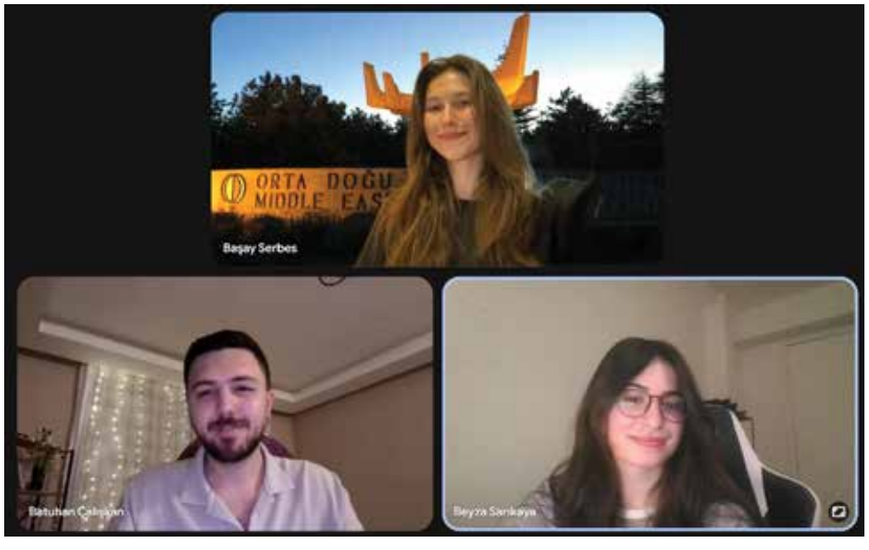
Research Area: International Relations & Security Studies

Project Team Members: Esma Beyza Sarıkaya, Başay Serbes and Batuhan Çalışkan

Project Supervisors: Prof. Işık Kuşçu Bonnefant

Abstract:

The Democratic Peace Theory (DPT) posits that domestic institutional constraints prevent democracies from engaging in conflict with each other. This research challenges that binary outlook by introducing a novel simulation, "The Power Matrix," which tests state behavior in zero-sum crises. Using a Scenario-Based Mechanism Tracing methodology, the study models conflicts between varying regime types (full democracy, flawed democracy, hybrid regime, and authoritarian regime). It utilizes a 4-Dimensional Payoff Matrix (Democracy, Economy, Public Opinion, and International Prestige) to quantify the non-military costs of strategic escalation. Consequently, we argue that structural pressure, rather than institutional design, is the primary driver of escalation, often forcing democratic leaders to mirror the aggressive tactics of their authoritarian rivals. These findings suggest that material necessity often overrides institutional norms, qualifying the explanatory power of DPT in high-stakes resource conflicts.

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