

MD MIRAJ AREFIN

mirajarefin1999@gmail.com | [Personal Website](#) | [Google Scholar](#) | [GitHub](#) | [LinkedIn](#)

RESEARCH INTERESTS

Robotic Ultrasound System Surgical Robotics Robot Learning Robot Dynamics and Control

EDUCATION

Middle East Technical University (METU), Turkey Sep 2025 - July 2027 (Expected)

MS in Robotics

Advisors : Dr. Mehmet Efe Tiryaki & Dr. Erol Sahin

Thesis: Autonomous Robot-assisted echocardiography system design

Khulna University of Engineering & Technology (KUET), Bangladesh Jan 2018 - June 2024

B.Sc. in Mechanical Engineering

RESEARCH EXPERIENCE

Robotic Ultrasound Imaging System Oct 2025 - Present

Graduate Research Assistant, Medical Robotic Systems Lab, METU

Supervisor: Dr. Mehmet Efe Tiryaki

- **Deformation-Aware Multimodal Control (Ongoing)**: Developing soft-tissue deformation tracking and ultrasound view stabilization by using RGB-D point clouds with B-mode features on a Franka Research 3.
- **Learning-Based Acoustic Recovery and View Optimization (Ongoing)**: Designing β -VAE and ensemble CVAE latent dynamics with risk-aware CEM-MPC for acoustic coupling recovery and ultrasound image optimization.
- **Contact-Aware Impedance Control**: Developed image-guided impedance control with adaptive contact-frame updates and contact-conditioned force/torque taring.
- **B-Mode Contact Perception**: Developed force-independent contact detection and localization using ultrasound intensity profiles.
- **Hardware Validation (ICRA 2027 Submission)**: Achieved 1.46 ± 0.14 mm contact-localization RMSE and 36.3% lower peak compressive force on a Franka Research 3 across $\pm 15^\circ$ probe roll.
- **Multi-Orientation Trajectory Tracking**: Executed 50 mm ultrasound scans with 0.93–1.60 mm along-axis RMSE and < 0.50 mm surface-normal RMSE.
- **Predictive Admittance Control (TRC 2026)**: Developed stiffness-adaptive predictive admittance control on a UR5e, achieving 0.44 N force RMSE at 10 N and continuous 3D spiral scanning.

Fixed Wing VTOL for Emergency Medical Vaccine Supply  Sep 2023 – Mar 2024

Undergraduate Research Assistant, KUET

Supervisor: Dr. Md. Ashraful Islam

- Designed and constructed a hybrid fixed-wing VTOL aircraft (8 kg take-off weight) for emergency medical transport applications.
- Developed a modular airframe achieving successful VTOL flight testing with approximately 5 minutes endurance.

PUBLICATIONS

Submitted Manuscript

- [S1] **Miraj Arefin** and M. E. Tiryaki. “Contact-Aware Impedance Controller for Robot-Assisted Ultrasound Imaging.” **Submitted to IEEE ICRA 2027**. [\[Research overview !\[\]\(d2e7ab8be3672de80a97fbb6ee01d2c9_img.jpg\)](#)

Conference Publications

- [C4] **Miraj Arefin** and M. E. Tiryaki. “Tissue Stiffness Predictive Admittance Control for Robot-Assistive Ultrasound Imaging.” *7th Turkish Robotics Conference*, 2026. Poster. [\[Poster\]](#) [\[🔗\]](#)
- [C3] A. H. Arif, M. M. Abedin, S. Das, S. E. Faruquei, A. Rahaman, and **Miraj Arefin**. “Automated Kidney Tumor Detection and Segmentation Using YOLO11 and Grad-CAM.” *International Informatics and Software Engineering Conference (IISEC)*, 2026. [\[DOI\]](#) [\[🔗\]](#)
- [C2] M. T. Rana, **Miraj Arefin**, N. Sharmin, H. A. Begum, M. F. Raihan, and A. Rahman. “Dynamic Modeling and Propulsion System Analysis with LQR-Based Control System for Enhanced Performance of a Lighter-Than-Air Aerial Drone.” *DELTA's* 2024. [\[DOI\]](#) [\[🔗\]](#)
- [C1] N. S. Mooaz, **Miraj Arefin**, S. R. Dhruvo, and A. Ahmed. “Transforming UAV Design: Coandă-Based Lift Generation for Enhanced Aerial Performance.” *International Conference on Electrical Information and Communication Technology (EICT)*, 2023. [\[DOI\]](#) [\[🔗\]](#)

Journal publications

- [J3] M. F. Rabbi, R. Sarker, J. Becker, A. R. Badsha, **Miraj Arefin**, I. Zahan, M. Arifuzzaman, M. A. Al Bari, and M. G. Kibria. “Investigating the Shear and Thermal Behavior of Additively Manufactured Wood-PLA Biocomposites Including a Life Cycle Assessment.” *Journal of Natural Fibers*, vol. 23, no. 1, article 2640270 (2026). [\[DOI\]](#) [\[🔗\]](#)
- [J2] M. M. M. Haque, S. R. Dhruvo, A. Z. Pranto, A. Ahmed, **Miraj Arefin**, M. Arifuzzaman, and M. S. Islam. “Impact of Process Parameters and Material Selection on the Mechanical Performance of FDM 3D-Printed Components.” *Hybrid Advances* (2025). [\[DOI\]](#) [\[🔗\]](#)
- [J1] **Miraj Arefin**, D. Mondal, and M. A. Islam. “Thermodynamic Analysis of Cascade Refrigeration System using Low GWP Refrigerants for Low-Temperature Application.” *Energy Conversion and Management: X*, vol. 24, article 100722 (2024). [\[DOI\]](#) [\[🔗\]](#)

SELECTED PROJECTS

Graduate Course Projects

2025 – 2026

Manipulator Joint Space Control Using Deep Reinforcement Learning [\[🔗\]](#)

- Trained a 6-DOF UR5e manipulator policy using PPO across 32 parallel MuJoCo environments, bypassing analytical inverse kinematics.
- Implemented a 4-stage workspace curriculum, achieving > 85% reaching success, and integrated analytical link-to-obstacle clearance rewards to encourage collision-free trajectories.

Robot Motion Planning using EB-RRT [\[🔗\]](#)

- Implemented a dynamic motion planner combining time-parameterized Risk-RRT with Elastic Band (EB) force-field optimization.
- Refined raw randomized paths via internal contraction and external obstacle-repulsive forces, significantly reducing path length and curvature while respecting robot velocity and acceleration limits.

Wi-Fi CSI signal-based Human Counting [\[🔗\]](#)

- Engineered a Transformer network with a 1D-CNN temporal feature extractor and Multi-Head Attention to detect human activities and occupancy counts from 3000×270 Wi-Fi CSI amplitude matrices.
- Benchmarked generalizability across completely unseen test environments, successfully mitigating room-specific multipath reflections and demonstrating robust zero-shot domain transfer.

Flash Joule Heating System for Turbostratic-Graphene Synthesis [\[🔗\]](#)

Mar 2023 – Sep 2023

Research Project / Supervisor: Dr. Md. Abdullah Al-Bari

- Designed and built a flash Joule heating system using a 70 mF capacitor bank and a custom AC–DC converter for charging to 300 V.
- Implemented Arduino-based switching for approximately 30 ms discharge pulses to rapidly heat carbon-black

feedstock upto 3000K temperature.

KUET Mars Rover (Team Durbar)

Mar 2022 – Feb 2023

Sub-Team Lead, Control Systems and Software

- Led control/software development for a rocker-bogie rover; developed its drive system and wrote C++ code for control.
- Designed and constructed a manipulator arm capable of lifting over 5 kg.

TECHNICAL SKILLS

Robotics: Robot Kinematics/Dynamics, Impedance and Force control, Reinforcement Learning, Motion Planning, Robot simulation (MuJoCo), Franka Research 3, Universal Robots (UR5e/UR3e), Arduino, Raspberry Pi, STM32, Pixhawk/ArduPilot, ROS2, TensorFlow, pytorch, OpenCV, PCL, Python, C/C++, OOP, MATLAB

Tools/Softwares: SolidWorks, AutoCAD, Blender, LaTeX, Inkscape, kdenlive, Adobe Illustrator

GRADUATE COURSE WORK

Robot Motion Planning And Control	Neurocomputers And Deep Learning
Linear Systems Theory II	Introduction to Robotics
Generative Models	Design of Intelligent Machines
Optimization	Fundamentals & Emerging Topics in Robotics

TEACHING AND TECHNICAL MENTORING

Summer Intern Mentoring

Summer 2026

Medical Robotic Systems Lab, METU

- Mentored two summer interns on motorizing a laparoscopic gripper module for planned integration with a UR5e robot arm for robot-assisted laparoscopic manipulation.

FabLab KUET

May 2022 – Apr 2023

Student Operator

- Trained more than 100 students in fabrication technologies, supported project prototyping, and operated 3D printers, CNC machines, and laser cutters.

LOOP

Apr 2020 – Apr 2022

Project Manager

- Organized Arduino-based robotics workshops for over 100 students and mentored student teams in robot design and programming.

CADers

Jun 2019 – Mar 2023

Information and Technology Officer

- Organized AutoCAD and SolidWorks workshops for over 200 students and developed CAD tutorials to support student learning.

REFERENCES

Dr. Mehmet Efe Tiryaki

Assistant Professor
Department of Mechanical Engineering
Middle East Technical University, Turkey
Email: etiryaki@metu.edu.tr

Dr. Erol Sahin

Professor
Department of Computer Engineering
Middle East Technical University, Turkey
Email: erol@metu.edu.tr