Cahit Ikbal Er

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Professional Summary

Ph.D. candidate working on planning and coordination for heterogeneous, energy-constrained multi-robot teams, such as drones (UAVs) that ride on and recharge from ground robots (UGVs). I formulate long-horizon missions such as aerial monitoring, ordered inspection, and collaborative exploration as NP-hard mixed-integer programs, and design polynomial-time algorithms with provable guarantees: feasibility, worst-case complexity, robustness to bounded disturbances, and probabilistic safety under online replanning. I validate them against exact solvers and metaheuristics, in Monte Carlo and ROS2/Gazebo simulation, and in multi-robot hardware experiments.

Education

Northeastern University — *Boston, MA*
PH.D. IN MECHANICAL ENGINEERING — *Expected: May 2028*
Concentration: Mechatronics • Candidacy achieved Fall 2024 • GPA 4.00/4.00

Northeastern University — *Boston, MA*
M.SC. IN ROBOTICS — *April 2026*
Concentration: Electrical and Computer Engineering • GPA 4.00/4.00

Bilkent University — *Ankara, Turkey*
B.SC. IN MECHANICAL ENGINEERING — *June 2023*
Comprehensive Scholarship • Top 0.15% nationwide in the national university entrance exam (2018)

Publications

- [1] **C. I. Er**, A. Kashiri, Y. Yazicioglu. **RSPECT: Robust and Scalable Planner for Energy-Aware Coordination of UAV–UGV Teams in Aerial Monitoring.** Journal of Intelligent & Robotic Systems (**JINT**), 2026. [paper] [code] [hardware] [video]
- [2] R. Fowler[*], **C. I. Er**[*], B. Johnsenberg, Y. Yazicioglu. **PRO-SPECT: Probabilistically Safe Scalable Planning for Energy-Aware Coordinated UAV–UGV Teams in Stochastic Environments.** IEEE/RSJ International Conference on Intelligent Robots and Systems (**IROS 2026**). [*]Equal contribution. [preprint] [video]
- [3] **C. I. Er**, S. Juttu, Y. Yazicioglu. **Energy-Aware Collaborative Exploration for a UAV–UGV Team.** IEEE/RSJ International Conference on Intelligent Robots and Systems (**IROS 2026**). [preprint] [code] [video]
- [4] **C. I. Er**, Y. Yazicioglu. **Robust and Scalable UAV–UGV Planning for Aerial Monitoring under Energy and Precedence Constraints.** American Control Conference (**ACC 2027**), under review. [preprint] [code]

Experience

Multi-Agent Robotics and Autonomy Lab (MuRAL), Northeastern University — *Boston, MA*
RESEARCH ASSISTANT — *Sep. 2023 – present*

- Designed RSPECT [1], an $O(mn + n^3)$ planner that assigns and routes multiple UAV–UGV teams, with proven feasibility and robustness; it plans 100 points and 10 teams in 3.4 s, beats tuned simulated annealing and genetic algorithms by up to 24% and 62% with about 1000× less computation, and robustness margins of up to 200 s add under 20% to mission time.
- Co-developed PRO-SPECT [2], a single-team $O(n^5)$ chance-constrained planner with online replanning that provably bounds the probability of mission failure by a user-set risk level; failure stayed within that level in 1,000-run Monte Carlo tests and in ROS2 wind simulation, with missions up to 61% shorter than a published baseline.
- Developed an $O(mn^3)$ algorithm [4] for multi-team task allocation and scheduling under precedence constraints (a mixed-integer program generalizing the mTSP) that jointly assigns, sequences, and times every visit, so teams wait rather than reroute; it plans 100 points and 10 teams in 0.34 s with nearly 10× shorter makespan than a decoupled baseline.
- Created an energy-aware air–ground exploration framework [3] that plans UAV and UGV tours as coupled orienteering problems; in C++/ROS/Gazebo simulation, the team reached 95% exploration 23–35% faster than a collaborative baseline.
- Co-developed and maintain the lab's multi-robot testbed (two Crazyflie UAVs and two TurtleBot4 UGVs under OptiTrack): ROS2 integration, PID-based UGV navigation, and safety layers including inter-robot collision avoidance; scaled it from one to two teams and developed the ROS2 simulations used to validate our planners.
- Ran the hardware experiments for [1] and [3]: deployed the exploration stack (mapping, frontier detection, viewpoint selection) on a Crazyflie–TurtleBot4 team that explored over 95% of an unknown environment in four energy-bounded tours; in a two-team mission with unknown obstacles, the robust plan handled a blocked meeting point without replanning.
- Extending [3] to teams with multiple UAVs per UGV, with auction-based task allocation and inter-UAV collision avoidance.

ME 5250: Robot Mechanics and Control, Northeastern University — *Boston, MA*

Teaching Assistant — *Sep. 2026 – present*

- Hardware section: maintain the remote robot-arm testbed (three PincherX-100 stations) that 30 students program in MATLAB for pick-and-place; recalibrate cameras, repair hardware, and debug student code.
- Simulation section: help students build and debug MuJoCo models that validate their closed-chain kinematic analysis.
- Hold office hours and grade homework, midterms, and projects.

Miniature Robotics Lab (MRL), Bilkent University — *Ankara, Turkey*

Undergraduate Researcher — *Feb. 2022 – July 2023*

- Design, fabrication, and locomotion analysis of Miniature Soft Quadruped (SQuad) robots.

ASELSAN — *Ankara, Turkey*

Candidate Engineer — *Dec. 2022 – June 2023*

- Designed and optimized Kalman filters in MATLAB and Simulink for SATCOM terminal and ground center motor control.

HAVELSAN and ROKETSAN — *Ankara, Turkey*

Engineering Intern — *Summers 2021, 2022*

- Mechatronics R&D on a tensile stress testing machine (HAVELSAN, 2022) and on canister systems (ROKETSAN, 2021).

Selected Projects

Temporal-Logic Mission Planning for UAV–UGV Teams

EECE 5698: Formal Methods for Dynamical Systems — *Spring 2025*

Formulated UAV–UGV coverage under Signal Temporal Logic specifications (safety, persistent, sequential, and periodic visits) as a mixed-integer program with Big-M encodings of regions, obstacles, and temporal operators; solved with Gurobi.

Robust Predictive Control Under Bounded Disturbance

ME 7374: Safe Control and Estimation — *Fall 2024*

Extended tube-based output-feedback MPC with a disturbance-informed nominal model and an adaptive blend with the standard controller; proved constraint satisfaction and reachability via robust invariant sets and a Luenberger observer.

Deep Reinforcement Learning for Navigation Under Stochastic Transitions

EECE 5614: Reinforcement Learning and Decision Making Under Uncertainty — *Spring 2026*

Implemented DQN, Double DQN, and Dueling DQN from scratch for a stochastic grid-world, with experience replay, soft target-network updates, and decaying epsilon-greedy exploration; compared architectures and ran a learning-rate sensitivity study.

Predicting Robot Navigation Failure with Tree-Based Ensembles

EECE 5644: Machine Learning and Pattern Recognition — *Fall 2025*

Built Decision Tree and Random Forest classifiers predicting navigation success over about 1,000 simulated trials; authored the pipeline adding eight geometric and obstacle-density features. Random Forest: 0.980 test accuracy, 0.995 ROC-AUC.

Skills & Coursework

Programming	Python, MATLAB, Simulink, C++, Julia; Gurobi, Optuna; Git, Docker, Linux
Robotics	ROS2, ROS, Gazebo, RViz, MuJoCo, Isaac Sim; Crazyflie, TurtleBot4, PincherX-100, E-puck2, OptiTrack, LiDAR; navigation, collision avoidance, occupancy mapping
Planning	Multi-robot task allocation, scheduling, and vehicle routing (TSP, mTSP, GTSP, OP, SOP); motion planning and exploration; planning under uncertainty and online replanning; temporal logic (STL, LTL, TWTL)
Control	Model predictive control (robust, tube-based), LQR, PID, Kalman filtering and state estimation
Optimization	Mixed-integer, linear, and dynamic programming; robust and stochastic optimization; metaheuristics
Learning	Deep reinforcement learning, supervised learning, neural networks; PyTorch, scikit-learn
Coursework	Algorithms for Optimization, Numerical Optimization Methods, Advanced Control Engineering, Safe Control and Estimation, Formal Methods for Dynamical Systems, Mobile Robotics, Robotics Sensing and Navigation, Machine Learning and Pattern Recognition, Reinforcement Learning

Service

2026 **Reviewer,** IEEE Transactions on Automation Science and Engineering (T-ASE)
2026 **Reviewer,** IEEE International Conference on Robotics and Automation (ICRA)
2026 **Reviewer,** American Control Conference (ACC)