Omer Kurkutlu

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Ph.D. Candidate in Electrical and Computer Engineering

Location: Chicago, IL, USA

Objective

Ph.D. student in Electrical and Computer Engineering with strong hands-on experience in robotics, autonomous systems, and embedded AI. Specialized in vision-based navigation, deep reinforcement learning, and energy constrained edge computing. Experienced in building complete robotic systems spanning perception, control, simulation, and real world deployment using NVIDIA Isaac Lab, ROS, embedded hardware, and learning-based methods.

Education

- **University of Illinois Chicago** — Chicago, IL
  Ph.D. in Electrical and Computer Engineering — *2024 – Present*
- **University of Notre Dame** — Notre Dame, IN
  Ph.D. in Electrical Engineering — *2023–2024*
- **University of Pune** — Pune, India
  Bachelor of Engineering in Computer Engineering — *2015–2021*

Skills

- **Programming & Systems**: C, C++, Python, Embedded C, Yocto
- **Robotics & Simulation**: NVIDIA Isaac Lab (Isaac Sim), ROS/ROS2, Gazebo, MoveIt, RViz, SOFA, SolidWorks, SketchUp, 3D Printing
- **Learning-Based Control & Perception**: Deep Reinforcement Learning (SAC, PPO, DQN); visual perception with YOLO, PyTorch, TensorFlow, FOMO
- **Embedded & Edge AI Systems**: Arduino, Raspberry Pi, NVIDIA Jetson, STM32, ESP32, Intel RealSense, TinyML/TFLite
- **Development Tools**: Linux, Docker, Git/GitHub, OpenCV

Experience

- **Research Assistant** — University of Illinois Chicago
  Conducting research under the supervision of Dr. Arman Roohi on four major projects. — *Aug 2024 – Present*
  - **Vision-Based Autonomous Tiny Drone with DRL-Based Navigation**:
    To enable fully autonomous flight for tiny drones in dynamic environments, developed and trained a deep reinforcement learning framework integrating vision-based obstacle detection with control policies for real-time navigation. Designed the perception-to-action pipeline and validated performance in ROS/Gazebo and NVIDIA Isaac Sim to improve safety and flight efficiency. Successfully deployed the system on a **Crazyflie 2** equipped with the **AI-deck (GAP8)**, demonstrating that complex navigation tasks can be executed on resource-constrained tiny aerial platforms.
    (Isaac Sim+ROS2 / ROS1+Gazebo / C++ / Python / Docker / Linux / DRL / SAC and PPO / YOLOv8+ SSD+FOMO / Tiny Drones)
    (Click for video)
  - **Lightweight Temporal Consistency for Grid-Based Obstacle Detection in Edge Devices**:
    Developed and deployed a lightweight obstacle detection framework for edge devices that improves perception robustness through distance-aware obstacle representation and temporal consistency. The method stabilizes predictions across frames and enables reliable obstacle awareness, and was integrated into real-time lightweight navigation pipelines for resource-constrained robotic platforms.
    (YOLOv8 / SSD / FOMO / Edge AI / Embedded Deployment)
    (Click for video)
  - **TinyML in Energy Harvesting Systems**:
    Developed a batteryless edge computing system integrating TinyML and intermittent computing. Designed an energy harvesting system with supercapacitors for adaptive power management. Implemented image processing, BLE communication, and person detection on an Arduino Nano 33 BLE, ensuring efficient task execution based on available energy.
    (Intermittent Computing / Embedded Systems / Energy Harvesting / Batteryless Systems)
  - **Lightweight Mapless Navigation Framework in a Dynamic Environment**:
    Developed a mapless, lightweight navigation framework focused on path planning for autonomous robots operating in dynamic environments, implemented on microcontroller-level hardware to enable real-time operation under strict compute, memory, and energy constraints. Designed a grid-based representation and implemented efficient step by step A* heuristic path planning to achieve reliable goal-directed navigation on resource-constrained platforms.
- **Teaching Assistant** — University of Illinois Chicago
  Computer Architecture (Senior-Level Undergraduate Course) — *Jan 2025 – Present*
  - **Instructional Support**: Delivered a tutorial on **SimpleScalar** simulation for final projects and assisted students with core topics including pipelining, memory hierarchy, and performance evaluation.
  - **Assessment & Mentorship**: Graded assignments and exams, provided detailed feedback, and supported students in understanding architectural design trade-offs and problem-solving techniques.
- **Research Assistant** — University of Notre Dame
  Conducted research under the supervision of Dr. Yasemin Ozkan Aydin on two major projects. — *May 2023 – Aug 2024*
  - **Salamander-Inspired Quadruped Robot**:
    Investigated the impact of spinal joint actuation on quadrupedal locomotion using Deep Q-Network (DQN) reinforcement learning, aiming to improve speed and efficiency in target-directed navigation tasks. Designed the robot in SolidWorks, generated a URDF model, and integrated it into simulation environments for DRL training. Built the physical platform using Dynamixel servo motors and deployed the learned policies on a Raspberry Pi. Conducted experiments across different terrain conditions and compared configurations with and without an active spinal joint, demonstrating improved robustness and locomotion performance with coordinated spinal–limb dynamics.
    (SolidWorks / ROS1 /Gazebo / DRL / DQN)
    (Click for video).
  - **Autonomous Tunnel Burrowing System**: Developed an autonomous tunnel-burrowing robotic system consisting of a mobile base and a gantry-mounted robotic arm capable of executing excavation tasks based on user-defined tunnel dimensions. Designed and fabricated the gantry system in SolidWorks and implemented it both in real hardware and in ROS/Gazebo simulation. Integrated a RealSense depth camera for environment perception and a torque sensor to estimate interaction forces with soil and mud during excavation. Created multiple experimental scenarios with varying soil types and dust conditions, and designed interchangeable end-effectors optimized for different terrain properties. The system was validated in both simulation and real-world field tests, demonstrating fully autonomous operation.
    (C++ / Python / ROS / Gazebo / Sim2Real / URDF / SLAM / Point Cloud / Robot Manipulation / Mobile Robot / Solidworks)
    (Click for video).
- **Robotics Software Engineer** — Kontrolmatik Technologies
  Motion Planning & Robot Control — *Jan 2022 – Sep 2022*
  - **Robot Motion Planning**: In my role with Collaborative Robots, I led the implementation of motion-planning, inverse-kinematics, Collision-Detection, and Hardware-Interfaces for Simulation and Real-Robots in real-time. I also managed the System and Software Architecture of the project. Using Ros/Moveit packages, I calculated inverse kinematics via the D-H Method in C++. I researched and applied various algorithms like OMPL and Chomp for motion planning and collision detection. Additionally, I simultaneously controlled a UR5e Robot from RViz while running Gazebo simulation in RTOS.
    (C++ / Linux / ROS /Gazebo / MoveIt / RTOS/ SolidWorks / OMPL / Kinematics)

- **Entrepreneur** — OK Dynamics / 3-Axis 3D Print
  Co-founded two startups: — *Jan 2021 – Apr 2023*
  - **OK Dynamics**: Co-founded a startup focused on quadruped robotics. Led the design and development of OK1, a custom four-legged robot featuring complete mechanical, electronic, and software integration. Presented the project at universities and government programs to promote innovation and secure funding. (Click for video)
  - **3-Axis 3D Print**: Provided 3D printing solutions and developed automation systems for industrial applications, delivering tailored solutions for various clients in the manufacturing sector. (Click for video – Digital Conveyor Project)

Selected Projects

- **OK-1: Custom Quadruped Robot**:
  Designed and developed a fully custom four-legged robot as a complete end-to-end robotics system covering mechanical design, electronics, control, and simulation.
  - **Mechanical Design & Prototyping**: Designed the robot structure, joints, and remote controller in **SolidWorks**; performed full CAD simulation and prepared components for fabrication and assembly.
  - **Control System Development**: Implemented inverse kinematics, multi-servo gait generation, and full-body pose control using **C/C++** and embedded control logic for stable locomotion.
  - **Simulation & Software Integration**: Built and validated the robot model in **ROS** and **Gazebo**, enabling testing of locomotion strategies and control algorithms before hardware deployment.
  - **Perception & Software Stack**: Developed supporting software tools using **Python**, **OpenCV**, and **TensorFlow** for experimentation with perception and learning-based extensions. (Real robot video) (Gazebo Simulator video) (GitHub Link)
- **Custom 3D Printer Design and Development**:
  Designed and built a fully functional FDM 3D printer from scratch, covering mechanical design, electronics integration, firmware configuration, and system validation.
  - **Mechanical Design**: Designed the full printer frame, motion system, and component layout in **SolidWorks**, optimizing structural rigidity and ease of assembly for a build volume of **25×25×30 cm**.
  - **Embedded System Integration**: Assembled and integrated stepper motors, drivers, sensors, and control electronics using **Arduino**-based control boards and custom wiring architecture.
  - **Firmware Development**: Configured and customized the open-source **Marlin firmware** in **C/C++**, tuning motion parameters, thermal control, and safety features for reliable printing performance.
  - **Connectivity & Features**: Enabled **Wi-Fi connectivity** for remote monitoring and control, and validated printing accuracy through calibration and iterative testing.
  - **Project Outcome**: Delivered a fully operational custom printer used for rapid prototyping and hardware development in robotics projects. (Printer Video)
- **AI-Powered Humanoid Robot**:
  Designed and developed an 18-DOF humanoid robot integrating mechanical design, embedded control, and AI-based perception.
  - **CAD Design & Simulation**: Modeled and simulated the full robot in **SolidWorks**, including 6 DOF per leg and 3 DOF arm, ensuring kinematic feasibility and structural integrity.
  - **System Design & Control**: Implemented motion control architecture using **Arduino** and **Raspberry Pi**, enabling coordinated multi-joint actuation and remote operation.
  - **Electronics & Power Distribution**: Designed a custom power distribution and control board in **Eagle**, supporting stable voltage regulation and actuator interfacing.
  - **AI-Based Perception**: Developed real-time object and face detection using Python, OpenCV.

Publications and Presentations

- **LiMPNet: Lightweight Multi-Sensor Perception and DRL Navigation for Tiny Drones in Mapless Environments**: *Proceedings of the AAAI Symposium Series (**AAAI**), 2025*
  - **Summary**: Presented a lightweight multi-sensor perception and deep reinforcement learning framework enabling fully mapless navigation for autonomous tiny drones under severe size, weight, and power constraints.
- **Lightweight Temporal Consistency for Grid-Based Obstacle Detection in Edge Devices**: *Workshop on AI for Autonomous Systems (**AI4AS**), co-located with IEEE International Conference on Autonomic Computing and Self-Organizing Systems (**ACSOS**), 2025*
  - **Summary**: Proposed a lightweight and robust obstacle detection framework tailored for edge devices with sub-MB memory, introducing temporal consistency to improve reliability under strict latency and resource constraints.
- **Sunsift: Solar-Powered Intelligent Sensing Through Informative Sample Selection**: *IEEE International Conference on Autonomic Computing and Self-Organizing Systems Companion (**ACSOS-C**), 2025*
  - **Summary**: Proposed an energy-aware intelligent sensing framework enabling batteryless CNN inference on solar-powered IoT devices through informative sample selection and adaptive execution.
- **Autonomous Integrated Sensing and Processing for BioRadar: Advancing Non-Invasive Biomedical Monitoring and Signal Analysis**: *IEEE MTT-S International Microwave Biomedical Conference (**IMBioC**), 2025*
  - **Summary**: Developed an integrated sensing and processing system for continuous-wave BioRadar, enabling non-invasive vital sign monitoring through on-device signal processing on embedded platforms.
- **Evaluating Tools for Collective Soil Excavation: Challenges and Insights**: *Springer Proceedings on Advanced Robotics (SPAR), 2025* (Accepted)
  - **Summary**: Conducted a comparative evaluation of excavation tools for collective soil excavation using terrestrial robot swarms, identifying key limitations in coordination, efficiency, and real-world deployment.
- **Coordinating Spinal and Limb Dynamics for Enhanced Sprawling Robot Mobility**: *Mechanical Intelligence in Robotics Workshop at ICRA 2025 (arXiv:2504.14103)*
  - **Summary**: Proposed a hybrid control framework combining biologically inspired gait design with deep reinforcement learning to coordinate spinal and limb motion, improving robustness of a salamander-inspired quadruped robot across varying terrains.

Awards & Honors

- **Sigma Xi Associate Membership**: Nominated and inducted into the scientific research honor society.
- **DAC 2026 Young Fellows Program**: Selected participant for the Design Automation Conference Young Fellows Program.

References

- **Arman Roohi**: Associate Professor, University of Illinois Chicago (UIC)
  Email: aroohi@uic.edu
- **Shaahin Angizi**: Assistant Professor, New Jersey Institute of Technology (NJIT)
  Email: shaahin.angizi@njit.edu
- **Sangsin Lee**: DRAM Engineer, SK hynix
  Email: sangsin1.lee@sk.com