Emek Barış Küçüktabak

Robotics Researcher · PhD Candidate · Northwestern University · Shirley Ryan Ability Lab
Chicago, IL
baris.kucuktabak@gmail.com | kucuktabak.com | emekBaris | emek-barış-küçüktabak

Education

Northwestern University — *Chicago, IL*
PhD in Mechanical Engineering — *Anticipated Summer 2024*
- Research Topic: Physical Human-Robot-Human Interaction
- Advisers: Prof. Kevin Lynch and Prof. Jose Pons
- Relevant Courses: Robotic Manipulation, Embedded Systems in Robotics, Machine Learning

ETH Zürich — *Zürich, Switzerland*
MS in Mechanical Engineering — *June 2019*
- Thesis: Interaction Force Control for a Series Elastic Actuated Exoskeleton
- Thesis Advisers: Prof. Marco Hutter, Dr. Farbod Farshidian, Dr. Yves Zimmermann
- GPA: 5.84/6.00 - Graduated with distinction. Top 5%
- Relevant Courses: Robot Dynamics, Programming for Robotics - Introduction to ROS, Autonomous Mobile Robots, Dynamic Programming and Optimal Control, Recursive Estimation, Theory of Robotics and Mechatronics

Middle East Technical University — *Ankara, Turkey*
BS in Mechanical Engineering — *June 2017*
- GPA: 3.95/4.00 - Graduated as the top-ranking student (1/333)
- Relevant Courses: Dynamics, Control Systems, System Dynamics, Design of Control Systems, Mechatronic Design

Skills

Robotics ROS, Gazebo, CANOpen
Programming C++ , Python, Matlab/Simulink, Git

Experience

Honda Research Institute USA — *San Jose, CA*
Research Intern — *January 2023 - April 2023*
- Developed a novel framework for bilateral physical interaction of two robots with hierarchical safety constraints.
- Used this framework to mediate safe physical interaction between two humans.
- Submitted a US Patent application.

Legs+Walking Lab, Shirley Ryan Ability Lab / Northwestern University — *Chicago, IL*
PhD Candidate: Robot-Mediated Physical Human-Human Interaction — *September 2019 - Summer 2024*
- Developed, implemented, and tested interaction force controllers for a floating-base bipedal lower-limb exoskeleton (Video, Paper).
- Developed an infrastructure that allows haptic coupling of two bipedal exoskeletons (Video, Paper).
- Involved in the development of an open-source software stack written in C++, for real-time robot control, visualization and simulation (GitHub).
- Published a literature review on 'human-robot-human' interaction (Paper).
- Evaluating the effectiveness of physical 'human-robot-human' interaction for a teacher-student application.
- Supervised Master's students.

Robotic Systems Lab, ETH Zürich — *Zürich, Switzerland*
MS: Interaction Force Control for a Series Elastic Actuated Exoskeleton (Thesis) — *October 2018 - June 2019*
- Modeled and simulated the physical interaction between human arm and exoskeleton in ROS/Gazebo simulation environment (Video).
- Developed a variety of interaction force control algorithms with a focus on haptic transparency for a series elastic actuated upper-limb exoskeleton named ANYexo (Paper).

Robotic Systems Lab, ETH Zürich — *Zürich, Switzerland*
Semester Thesis: Executing Tasks with a Walking Manipulator: Opening Doors (Video) — *February 2018 - June 2018*
- Designed, simulated and validated door opening maneuvers for a quadrupedal (ANYmal) with a manipulator on top.

Control Laboratory, Middle East Technical University — *Ankara, Turkey*
Graduation Project: Cable Driven Aerial Camera System (Video). — *September 2016 - February 2017*
- Involved in the design and development of a cable driven aerial camera system as the lead of a six-people team.

Mechanical System Design Lab, Tokyo Institute of Technology — *Tokyo, Japan*
Research Exchange Student — *October 2015 - August 2016*
- Modeled and simulated a cable driven earthquake simulator (Video).

Aerospace Mechatronics Lab, McGill University — *Montreal, Canada*
Research Intern — *June 2015 - September 2015*
- Designed and simulated a flip recovery maneuver for a quadcopter.

Teaching

Biomedical Robotics (BME 467) — *Chicago, IL*
Guest Lecturer — *January 2023*
- Ran a class on the interaction force control of upper-limb and lower-limb exoskeletons.

Robotic Manipulation (ME 449) — *Chicago, IL*
Teaching Assistant — *2020 & 2021 Fall*
- Ran two classes related to mobile manipulation and trajectory generation.
- Wrote and graded assignments.
- Held office hours.

Robotic Simulation (ME 495) — *Chicago, IL*
Teaching Assistant — *2021 Spring*
- Assisted students to develop robot simulation scenarios on different platforms.
- Graded assignments.

Presentations

2023 IEEE International Conference on Rehabilitation Robotics (ICORR) — *Singapore*
Podium Presentation — *September 2023*
- Virtual Physical Coupling of Two Lower-Limb Exoskeletons

2022 Summer School on Neurorehabilitation — *Baiona, Spain*
Organizer and presenter of the Workshop: Design and Controllers of Exoskeleton — *June 2022*
- Demonstrated virtual physical coupling between an ankle and hip-knee exoskeleton

2022 IEEE IROS- Workshop on Assistive Robotic Systems for Human Balancing and Walking: Emerging Trends and Perspectives — *Kyoto, Japan (Remote)*
Presenter — *October 2022*
- Interaction Force Control for a Lower-Limb Exoskeleton

Awards & Scholarships

2019-21	**Murphy Scholarship**, Northwestern University	*Chicago, IL*
2019	**Fulbright Fellowship**, The Turkish Fulbright Office	*Chicago, IL*
2018	**Birkigt Scholarship**, ETH Zürich	*Zürich, Switzerland*
2017	**Top Ranking Student**, Mechanical Engineering Department, Middle East Technical University	*Ankara, Turkey*
2017	**Winner of the Undergraduate Design Project Competition**, METU Engineering Day	*Ankara, Turkey*
2016	**JASSO Scholarship**, Tokyo Institute of Technology	*Tokyo, Japan*
2015	**Mitacs Globalink Research Internship Scholarship**, McGill University	*Montreal, Canada*
2012	**Winner of the Firefighting Category**, Istanbul Technical University Robot Olympics	*Istanbul, Turkey*

Publications

- **Küçüktabak, E. B.**, Wen, Y., Kim, S. J., Short, M., Ludvig, D., Hargrove, L., Perreault, E., Lynch, K., and Pons, J. L. ***Haptic Transparency and Interaction Force Control for a Lower-Limb Exoskeleton***. IEEE Transactions on Robotics (T-RO), 2024. *(Accepted)*
- **Küçüktabak, E. B.**, Pons, J. L., Lynch, K., and Soltani Zarrin, R. ***Physical Human-Robot-Human Interaction with Hierarchical Safety Constraints***. IEEE Robotics and Automation Letters (RA-L), 2024. *(Under Review)*
- **Küçüktabak, E. B.**, Wen, Y., Short, M., Demirbaş, E., Lynch, K., and Pons, J. L. ***Virtual Physical Coupling of Two Lower-Limb Exoskeletons***. IEEE International Conference on Rehabilitation Robotics (ICORR), 2023.
- Vianello, L., **Küçüktabak, E. B.**, Short, M., Lhoste, C., Amato, L., Lynch, K., and Pons, J. L. ***Exoskeleton-Mediated Physical Human-Human Interaction for a Sit-to-Stand Rehabilitation Task***. IEEE International Conference on Robotics and Automation (ICRA), 2024. *(Under Review)*
- Short, M., Ludvig, D., **Küçüktabak, E. B.**, Wen, Y., Vianello, L., Perreault, E., Hargrove, L., Lynch, K., and Pons, J. L. ***Haptic Human-Human Interaction During an Ankle Tracking Task: Effects of Virtual Connection Stiffness***. IEEE Transactions on Neural Systems and Rehabilitation Engineering (TNSRE), 2023.
- Kim, S. J., Wen, Y., Ludvig, D., **Küçüktabak, E. B.**, Short, M., Lynch, K., Hargrove, L., Perreault E.J. and Pons, J. L. ***Effect of Dyadic Haptic Collaboration on Ankle Motor Learning and Task Performance***. IEEE Transactions on Neural Systems and Rehabilitation Engineering (TNRSE), 2022.
- Zimmermann, Y., Sommerhalder, M., Song, J., Etter, B., **Küçüktabak, E. B.**, Riener, R., Wolf, P. ***Digital Guinea Pig: Merits and Methods of Human-in-the-Loop Simulation for Upper-Limb Exoskeletons***. IEEE International Conference on Rehabilitation Robotics (ICORR), 2022.
- **Küçüktabak, E. B.**, Kim, S. J., Wen, Y., Lynch, K. and Pons, J. L. ***Human-machine-human interaction in motor control and rehabilitation: A review***. Journal of Neuroengineering and Rehabilitation, 2021.
- Kim, S.J., Wen, Y., **Küçüktabak, E.B.**, Zhan, S., Lynch, K., Hargrove, L., Perreault. E., Pons, J. ***A Framework for Dyadic Physical Interaction Studies during Ankle Motor Tasks***. IEEE Robotics and Automation Letters (RA-L), 2021.
- Fong, J., **Küçüktabak, E.B.**, Crocher, V., Tan, Y., Lynch, K., Pons, J., Oetomo, D. ***CANopen Robot Controller (CORC): An open software stack for human robot interaction development***. Wearable Robotics: Challenges and Trends, 2020.
- Zimmermann, Y., **Küçüktabak , E.B.**, Farshidian, F., Riener, R., Hutter,M. ***Towards Dynamic Transparency : Robust Interaction Force Tracking Using Multi-Sensory Control on an Arm Exoskeleton***. IEEE/RSJIntenational Conference on Intelligent Robots and Systems (IROS), 2020.
- **Küçüktabak, E. B.**, Pelit, M. M., Orhan, Z. Ö. and Turgut, A. E. ***Indoor UAV Exploration Method with UWB Localization***. Turkish National Conference on Automatic Control, 2017.
- Matsuura, D., Ishida, S., Akramin, M., **Küçüktabak, E. B.**, Sugahara, Y., Tanaka S., Fukuwa N., Yoshida M. and Takeda Y. ***Conceptual Design of a Cable Driven Parallel Mechanism for Planar Earthquake Simulation***. ROMANSY 21 - Robot Design, Dynamics and Control, Springer International Publishing, 2016.

Patents

- **Küçüktabak, E. B.** and Soltani Zarrin, R. (2023). ***Robot-Mediated Physical Human-Human Interaction***. *(US Patent Pending)*.