

Behzad Farzanegan

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Education

Missouri University of Science and Technology (MST), Missouri, USA

Ph.D. Electrical Engineering (Control Systems) | GPA: 3.77/4.0 | Aug 2021 – May 2025 (Expected)

Amirkabir University of Technology, Tehran, Iran

M.Sc. Electrical Engineering (Control Systems) | GPA: 17.09/20 | Sep 2011 – Dec 2013

B.Sc. Electrical Engineering (Control Systems) | GPA: 17.41/20 | Sep 2007 – Jul 2013

B.Sc. Biomedical Engineering (Bio-Electric) | GPA: 17.43/20 | Sep 2007 – Sep 2011

RESEARCH INTERESTS

My research focuses on reinforcement learning-based optimal tracking control for nonlinear discrete-time systems, with applications to robotics and autonomous systems. A significant aspect of my work is lifelong learning-based optimal controllers, where the controller continuously learns from past experiences to improve future performance. I also emphasize safety-aware and explainable AI, ensuring the reliability and interpretability of autonomous decision-making systems. Beyond my research, I explore machine learning applications in cyber-physical systems, including vision-based robotic manipulation and localization, motion planning, perception, SLAM, and mapping for real-world autonomous navigation.

Research Experience

Graduate Research Assistant, Mentor: Dr. Jag Sarangapani

Missouri University of Science and Technology, Rolla, MO, USA

Sep 2021- Present

- Implementing and testing reinforcement learning-based optimal tracking control for mobile robots, UAVs, and autonomous cars using QBot and QCar Quanser platforms with hardware-in-the-loop (HIL) simulations and with ROS2
- Developed a multi-model safety-aware deep reinforcement learning-based output feedback control system for Autonomous Surface Vessels (ASVs), integrating path planning with the A* method and object avoidance techniques
- Developed safe reinforcement learning-based control for Autonomous Underwater Vehicles (AUV) using Deep Neural Networks (DNN) in MATLAB/Simulink, reducing a notable cost of 31%
- Designed multi-tasking online optimal tracking control for robotic manipulators using hybrid lifelong learning to mitigate catastrophic forgetting
- Accomplished explainable and safe deep NN-based optimal controller for Shipboard Power Systems (SPS) with Explainable AI (XAI) that constructs an explainer model using the SHapley Additive exPlanations (SHAP) toolbox in Python
- Drove lifelong learning-based safe zero-sum-game optimal control for safe cargo transfer in the ocean under wave disturbances

Visiting Scholar, Mentor: Dr. Mohsen Zamani

University of Newcastle, Newcastle, Australia | Jan 2018-July 2018

- Designed a data-driven distributed optimal control and state estimation for nonlinear interconnected systems using Neural Networks (NN), reducing both cost and computational burden
- Developed an NN-based optimal control and state estimation for non-affine nonlinear systems with control input saturations application to Surface Effect Ship (SES) in MATLAB/Simulink, achieving 97% vertical motion damping

Research Assistant, Mentors: Dr. Mohammad Bagher Mehnaj and Dr. A.A Suratgar

Amirkabir University and Technology, Tehran, Iran | Sep 2013- Dec 2017

- Designed distributed Power System Stabilizers (PSS) based on Genetic Algorithm (GA) for New England IEEE 39-Bus using Phasor Measurement Units (PMU) data.
- Developed gradient ascent algorithm based on possibilistic fuzzy C-means for clustering noisy data, moving iteratively cluster centers to high-density regions by maximizing a cluster validity center.
- Programmed ATmega16 microcontrollers to measure the temperature of the wax actuator using TMP 36 temperature sensor to implement real-time embedded PWM controller for micro peristaltic pump.

- Designed sliding mode control of MEMS mirror plate actuators for an optical switch: Application to large channel counts.

Projects

State Estimation and Control for QCar

- Implemented Kalman filters for sensor fusion and state estimation using IMU and gyro data on the Quanser QCar test bench.
- Designed and deployed PID controllers to enhance QCar's motion stability and control accuracy.

Bumper Robot Development

- Designed and built a bumper robot from scratch using ROS2, Python, and C++, incorporating a custom joystick interface and a simple controller leveraging ROS2 control with Bayesian state estimation for odometry.

Autonomous Car Simulation

- Applied Model Predictive Control (MPC) and PID to an autonomous car, simulating and animating the system in Python.
- Conducted localization through sensor fusion using GNSS, IMU, and LiDAR.

Self-Driving Car with CNN

- Programmed a fully functional self-driving car using Convolutional Neural Networks (CNN) and computer vision to identify and follow lane lines on a road in Python with Keras and ROS2.

UAV Design and Simulation

- Designed and simulated a 12-degree-of-freedom UAV using MPC and Kalman filter for state estimation.

Teaching Experience

Lecturer

- *University of Kashan, Iran* | Jan 2019 – Jul 2019 – Linear Control Systems
- *Feiz Institute of Higher Education, Iran* | Sep 2013 – Jan 2014 – Linear, Nonlinear, and Modern Control Systems

Teaching Assistant

- *Amirkabir University of Technology, Iran* | Sep 2011 – Dec 2013 – Engineering Mathematics, Linear Control Systems

Publications

Google Scholar: <https://scholar.google.com/citations?user=kyEt7S8AAAAJ&hl=en&inst=15611845720231691803>

Journal Papers

- Behzad Farzanegan**, Jagannathan Sarangapani. "Multi-Model Safety Aware Deep Reinforcement Learning-based Output Feedback Control of Autonomous Surface Vessels." IEEE Journal of Oceanic Engineering (submitted)
- Behzad Farzanegan**, Jagannathan Sarangapani. "Explainable and Safety Aware Deep Reinforcement Learning-based Control of Nonlinear Discrete-Time Systems Using Neural Network Gradient Decomposition." IEEE Transactions on Automation Science and Engineering (revised)
- Behzad Farzanegan**, M.B. Menhaj, and A.A. Suratgar. "Data-Driven Distributed Optimal Control Using Neighborhood Optimization for Nonlinear Interconnected Systems." Journal of Optimization Theory and Application (2024)
- Behzad Farzanegan**, Jagannathan Sarangapani. "Lifelong Safe Optimal Adaptive Tracking Control of Nonlinear Strict-feedback Discrete-time Systems " International Journal of Adaptive Control and Signal Processing (2024)
- Behzad Farzanegan**, Jagannathan Sarangapani. "Continual Reinforcement Learning Formulation for Zero-Sum Game-based Constrained Optimal Tracking." IEEE Transactions on Systems, Man and Cybernetics: Systems (2023)
- Behzad Farzanegan**, Rohollah Moghadam, Jagannathan Sarangapani, P. Natarajan. "Optimal Adaptive Tracking Control of Partially Uncertain Nonlinear Discrete-time Systems using Lifelong Hybrid Learning " IEEE Transactions on Neural Networks and Learning Systems (2023)
- Behzad Farzanegan**, Amir A. Suratgar, Mohammad B. Menhaj, and Mohsen Zamani. "Distributed optimal control for continuous-time nonaffine nonlinear interconnected systems." International Journal of Control (2022)
- Behzad Farzanegan**, Mohsen Zamani, Mohammad B. Menhaj, and Amir A. Suratgar. "A neuro observer-based near-optimal control for nonaffine nonlinear systems with control input constraints." Control Theory and Technology (2021)
- Behzad Farzanegan**, Ehsan Esmailian, and Mohammad B. Menhaj. "A data-driven method for prediction and optimal control of ship motions for safe crew transfer to offshore wind turbines." Applied Ocean Research(2019)
- Behzad Farzanegan**, Ehsan Niafar, Ehsan Ranjbar, and Amir A. Suratgar. "Two MRAC Designs for the MEMS Based AC Voltage Reference Source. " Iranian Journal of Science and Technology, Transactions of Electrical Engineering (2019).

Hosein Saberi, Reza Sharbati, **Behzad Farzanegan**. "A gradient ascent algorithm based on possibilistic fuzzy C-Means for clustering noisy data." Expert Systems with Applications (2022)

Ehsan Esmailian, **Behzad Farzanegan**, Mohammad B. Menhaj, and Hassan Ghassemi. "A robust neuro-based adaptive control system design for a SES with uncertain dynamics and input saturation to cargo transfer at sea." Applied Ocean Research (2018)

Conference Papers

Behzad Farzanegan, Jagannathan Sarangapani. " Reinforcement Learning-Based Constrained Optimal Control of Strict-feedback Nonlinear Systems: Application to Autonomous Underwater Vehicles." 2024 IEEE Conference on Control Technology and Applications (CCTA) (2024)

Behzad Farzanegan, S. Jagannathan. "Continual Learning-based Optimal Output Tracking of Nonlinear Discrete-time Systems with Constraints: Application to Safe Cargo Transfer." 2023 IEEE Conference on Control Technology and Applications (CCTA) (2023)

Behzad Farzanegan, S. Jagannathan. "Optimal Tracking of Nonlinear Discrete-time Systems using Zero-Sum Game Formulation and Hybrid Learning: Application to Robotic Manipulators" 2023 American Control Conference (ACC) (2023)

Rohollah Moghadam, **Behzad Farzanegan**, S. Jagannathan. "Optimal Adaptive Output Regulation of Uncertain Nonlinear Discrete-time Systems using Lifelong Concurrent Learning." 2022 IEEE 61st Conference on Decision and Control (CDC) (2022)

Behzad Farzanegan, Ebrahim Navid Sajadi and Mohammad Bagher Menhaj. "An identification approach for unstable nonlinear systems with nonlinear parameterization using MRAC. " The 28th Iranian Conference on Electrical Engineering (2020).

Abolfazl Saadati Moghadam, Ehsan Ranjbar, **Behzad Farzanegan**, Amir Abolfazl Suratgar and Mohammad Bagher Menhaj. "Observer-Based Sliding Mode Control for MEMS-based AC Voltage Reference Source. " The 28th Iranian Conference on Electrical Engineering (2020).

Reza Naseri, **Behzad Farzanegan**, and Amir A. Suratgar. "Sliding Mode Control for an Optimal MEMS Micromirror Actuator with Parameter Uncertainty. " The 27th Iranian Conference on Electrical Engineering (2019).

K. Sharifi, Ali Raziabadi, and **Behzad Farzanegan** "Emotional State Recognition Based on Brain and Peripheral Signals Using Multi-Class Optimized FSVM Classifier." 5th National Conference on Electrical & Mechatronics Engineering (2019)

Behzad Farzanegan, Saman Dehghan Banadaki, and Mohammad B. Menhaj. "Direct Artificial Neural Network Control of Single-Link Flexible Joint Manipulator." The 4th International Conference on Control, Instrumentation, and Automation (2016)

Saman Dehghan Banadaki, Ahmad Afshar and **Behzad Farzanegan**. "Fault Detectability Condition of Networked Control System with Variable Network-Induced Delay. " The 4th International Conference on Control, Instrumentation, and Automation (2016).

PROFESSIONAL SERVICE

Journal Reviewer

- IEEE Transactions on Neural Networks and Learning Systems
- IEEE Transactions on Systems, Man and Cybernetics: Systems
- IEEE Transactions on Automatic Control
- Automatica
- Applied Ocean Research
- Artificial Intelligence Review

Conference Reviewer

- American Control Conference (ACC)
- Conference on Decision and Control (CDC)
- The 6th IFAC International Conference on Intelligent Control and Automation Sciences (ICON)

Skills

- **Programming Languages:** Python, MATLAB/Simulink, C/C++
- **Robotics Frameworks:** ROS2, SLAM, Gazebo, Path Planning (A*, RRT), PLC
- **Control and Estimation:** Kalman Filter, PID, MPC, Sensor Fusion, Localization, Optimal Control, Adaptive Control
- **Machine Learning:** Deep Learning, Reinforcement Learning, Computer Vision, Keras, OpenCV
- **Development Tools:** Version Control (Git), RTOS, Hardware-In-The-Loop (HIL), Linux, Microcontroller

Honors and awards

- Research funded through the Office of Naval Research (ONR) Grant N00014-21-1-2232, for Naval applications like Autonomous underwater vehicle (AUV), and surface effect ship (SES) learning-based optimal controllers
- Research funded through Army Research Office (ARO) agreements W911NF-21-2-0260 and W911NF-22-2-0185 for mobile robot learning-based optimal controllers
- Research funded through the Intelligent System Center (ISC) at Missouri University for learning-based optimal controllers
- Distinguished as an elite student at Amirkabir University of Technology

References

1. Dr. Jag Sarangapani

William A. Rutledge - Emerson Electric Company Distinguished Professor

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