

USMAN AHMED SYED

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EDUCATION

University of Illinois at Urbana-Champaign (UIUC)

PhD in Electrical and Computer Engineering

Specialization: Optimization, Controls and Machine Learning

Master's in Electrical and Computer Engineering

Specialization: Controls and Robotics

National University of Sciences and Technology (NUST), Pakistan

Bachelors in Mechatronics Engineering

RESEARCH INTERESTS

LLMs, Optimization, Reinforcement Learning, Deep learning, Robotics

EXPERIENCE

Research Assistant at University of Illinois, Urbana-Campaign

May 2015 – Present

Project: Capabilities of Large Language Models (LLMs) in Engineering

- Study the accuracy of the current state of the art LLMs in the engineering fields such as control systems, aerospace, transportation etc.
- Developing benchmarks for quantifying the accuracy of LLMs in the respective engineering domains.
- Improving the accuracy of LLMs using In-context learning based approach.
- Pre-training smaller open source LLMs for agent-based approach for controller synthesis.

Project: Online Non-stochastic Control vs. Retrospective Cost Adaptive Control, a Unified Algorithmic Perspective

- Study of the online optimization for adaptive controller design in the presence of unknown disturbances and a similar control theoretic framework called retrospective cost adaptive control (RCAC).
- Analyze the connections between online non-stochastic control and RCAC in the context of controlling linear systems subject to unknown non-stochastic disturbances.
- Synthesize a new online control algorithm by unifying the optimization and control-based approaches.

Project: Tracking Error Analysis of Online Optimization Methods via Sequential Semidefinite Programs (SDPs)

- Proposed a unified framework for analyzing the tracking error of the first-order online optimization methods.
- Formulated tracking error problem as a sequential SDP
- Exact analytical solutions for the proposed sequential SDPs and refined bounds for the tracking errors of online optimization algorithms.

Project: Analysis of Temporal Difference (TD) based Reinforcement Learning Algorithms

- Study of on-policy TD learning algorithms and its variants as Markov Jump Linear Systems (MJLS)
- Synthesis of exact solutions for the Mean Square Error for on-policy TD Reinforcement Learning algorithms.
- Finite time analysis of off-policy TD variant; Emphatic Temporal Difference Learning (ETD) algorithm.

Project: Bat-inspired Flight Control for a MAV

- Study of biological bat landing from high-speed video data and synthesis of bat inspired control strategy for agile movements of a micro-air vehicle (MAV).
- Design of a lightweight MAV with an adjustable center of mass.
- Design of feedback control law and its implementation on the MAV with on-board sensing and control.

Teaching Assistant at University of Illinois, Urbana-Campaign

Aug 2015 – Present

- Conducted lab sessions for **Introduction to Robotics** covering Robot Operating System (ROS), manipulator kinematics and computer vision topics like camera geometry and object detection.
- Taught **Control Systems** lab covering system identification and conventional and state space-based control.

Teaching Assistant at NUST, Pakistan

Aug 2011 – Dec 2013

- Taught labs for Object Oriented Programming and Data Structures using C++, Digital Image Processing using MATLAB, Instrumentation and Measurements, Electromechanical Systems and Solid Modelling.

Research Assistant at NUST, Pakistan

Aug 2011 – Dec 2013

Project Title: Path Planning for Mobile Robots

- Developed a Neural network based approach for planning the shortest path between start and goal locations.
- Devised a drivable space detection scheme using an unsupervised neural network
- Simulated the path planning approach in Player-Stage using C++.
- Experimental validation on a mobile robot platform.

TECHNICAL SKILLS

- **Programming:** C, C++, Python, MATLAB, Simulink, NI LabView.
- **Libraries/Platforms:** PyTorch, OpenAI, ROS, Opencv.
- **3D solid modeling and analysis:** Creo, AutoCAD.

SELECTED PUBLICATIONS

- **Usman Syed**, Ethan Light, Xingang Guo, Huan Zhang, Lianhui Qinc, Yanfeng Ouyang, Bin Hu, “Benchmarking the Capabilities of Large Language Models in Transportation System Engineering: Accuracy, Consistency, and Reasoning Behaviors”, under review in Transportation Research: Part C (TR_C).
- Darioush Kevian, **Usman Syed**, Xingang Guo, Aaron Havens, Geir Dullerud, Peter Seiler, Lianhui Qin and Bin Hu, “Capabilities of Large Language Models in Control Engineering: A Benchmark Study on GPT-4, Claude 3 Opus, and Gemini 1.0 Ultra” under review in American Control Conference (ACC).
- **Usman Syed**, Yingying Li and Bin Hu, “Online Nonstochastic Control vs. Retrospective Cost Adaptive Control”, IEEE Control Systems Letters (L-CSS), 2024.
- **Usman Syed**, E Dall'Anese and Bin Hu, “Bounds for the Tracking Error and Dynamic Regret of Inexact Online Optimization Methods: A General Analysis via Sequential SDPs”, under review.
- M. Umer Huzaifa, Dharshana Dimuthu, M. Aneeq uz Zaman and **Usman Syed**, “Simplified Modeling of Hybrid Soft Robots with Constant Stiffness Assumption”, IEEE International Conference on Robotics and Biomimetics (ROBIO) 2023.
- Bin Hu, **Usman Syed**, “Characterizing the Exact Behaviors of Temporal Difference Learning Algorithms Using Markov Jump Linear System Theory”, Advances in Neural Information Processing Systems (NeurIPS), 2019.
- Jonathan Hoff, **Usman Syed**, Alireza Ramezani, Seth Hutchinson, “Trajectory planning for a bat-like flapping wing robot”, IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), 2019.
- Khurram Kamal, Senthana Mathavan, Tayyab Zafar, Imran Moazzam, Ahsan Ali, **Usman Syed**, and Mujib Rahman, “Performance assessment of Kinect as a sensor for pothole imaging and metrology”, International Journal of Pavement Engineering, 2018.
- **Usman Syed**, Alireza Ramezani, Soon-Jo Chung, Seth Hutchinson, “From *Rousettus-Aegyptiacus* Landing to Robotic Landing: Regulation of CG-CP Distance Using a Nonlinear Closed-Loop Feedback”, IEEE International Conference on Robotics and Automation (ICRA), 2017.
- Alireza Ramezani, **Usman Syed**, Jonathan Hoff, Soon-Jo Chung, Seth Hutchinson “Describing Robotic Bat Flight with Stable Periodic Orbits”, Conference on Biomimetic and Biohybrid Systems, 2017.
- **Usman Syed**, Kunwar Faraz and Mazhar Iqbal, “Guided Autowave Pulse Coupled Neural Network based real time path planning and obstacle avoidance scheme for mobile robots”, Robotics and Autonomous Systems, Elsevier, 2014.
- **Usman Syed**, Faraz Kunwar, “Cellular Automata Based Real-Time Path-Planning for Mobile Robots”, International Journal of Advanced Robotic Systems, 2014.
- **Usman Syed**, Usman Ali Malik, Mazhar Iqbal and Kunwar Faraz, “A Guided Autowave PCNN for Improved Real Time Path Planning,” in Proc. Of IEEE International Joint Conference on Neural Networks (IJCNN), 2013.
- I. Moazzam, K. Kamal, S. Mathavan, **Usman Syed**, M. Rahman, “Metrology and visualization of potholes using the Microsoft Kinect sensor”, in Proc. Of 16th IEEE International Conference on Intelligent Transportation Systems, 2013.
- **Usman Syed**, Arsalan Akhter, Faraz Kunwar, “Cellular automata based real time path planning for mobile robots”, in Proc. Of 12th International Conference on Control Automation Robotics & Vision (ICARCV), 2012.