

VANSHAJ KHATTAR

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[Linkedin](#)

EDUCATION

Virginia Polytechnic Institute and State University
PhD in Electrical Engineering; **GPA: 3.57/4.00**

June 2021 - Present

Virginia Polytechnic Institute and State University
Masters of Science in Electrical Engineering; **GPA: 3.57/4.00**

August 2019 - May 2021

Masters Thesis title: Probabilistic Threat Assessment and proactive decision-making for crash avoidance in Autonomous Vehicles.

Delhi Technological University, New Delhi
B.Tech in Electrical and Electronics Engineering. **CGPA - 8.09/10**

August 2014 - May 2018

RELEVANT COURSES

Advanced Machine Learning; Stochastic Signals and Systems; Reinforcement Learning; Applied Linear Systems; Robotics and Automation; Optimization Techniques in ECE

RESEARCH PROJECTS

CityLearn Challenge - Multi-Agent Reinforcement Learning for Intelligent Energy Management *June 2021-present*

- Worked on zero-order Implicit RL method for control the energy of 9 buildings.
- Our method performed better than the Rule Based Controller for 9 buildings. The overall performance ration was 0.91.

Stochastic Model Predictive control (SMPC) for Crash Mitigation in Autonomous Vehicles - a Probabilistic Threat Assessment based approach *September 2019-present*

- Motion prediction of surrounding drivers is done using behavior-based Stochastic Reachable Sets. Driver behavior modelling is done using Hidden Markov Models. Future probability of crash is used as a measure of threat.
- SMPC approach is used and a chance constrained problem is formulated for crash avoidance; which is re-formulated in terms of convex constraints using feasible convex hulls in the safe space.

Safe Reinforcement Learning (RL) using Control Barrier Functions (CBF) for safety critical continuous control tasks *September 2020 - present*

- Model-free RL based controller is integrated with model-based CBF controller for safe policy exploration. Safety policy exploration is improved using recursive CBF based guiding control.
- Validation done on two nonlinear control systems: Inverted Pendulum and autonomous vehicle car following. TRPO-CBF based controller performed better than DDPG-CBF in terms of safety guarantees and convergence rate.

Investigating effect of opioids and other CNS drugs on the brain dynamics - A subject study *Feb 2020- present*

- Frequency power distributions for various bands in iEEG are calculated before and after the drug administration to the subject. EEG relationships within and across brain regions of various subjects are analysed i.e. coherence, power cross-correlation and spike field coherence are analysed.

Motion Planning for crash mitigation in autonomous vehicles using Bezier Curve Optimization *Jan 2020- May. 2020*

- Obstacle avoidance problem is converted to an optimisation problem for a vehicle with kinematic constraints where crash severity is minimised for an imminent collision
- A cubic Bezier curve trajectory generation method is used for creating a maneuver around the obstacle vehicle. Relative hitting heading angle is considered to account for the crash severity between two vehicles.

State-feedback control system design for control of Hovering Autonomous Underwater Vehicle (H-AUV) *Oct 2019- Dec. 2019*

- LQR and LQG controllers are designed for controlling the AUV from initial position to enter a narrow tunnel without contacting a barrier
- A Luenberger observer is designed using the LQR control feedback gains to meet the performance requirements. [Link](#)

Object detection using Single shot multi-box detector algorithm *Oct 2019- Dec. 2019*

- Implemented SSD model using PyTorch. Trained and tested it on different datasets. Evaluated model limitations, reproduced and confirmed paper results. [Github](#)

UNDERGRAD PROJECTS

Control system design for Cart Inverted Pendulum System

Aug. 2016- Jan. 2018

- Tuned PID values for experimental setup using classical control (Lag-Lead compensators) and optimal control (Robust LQR, Robust LQG) methods.
- Validated better performance of linear quadratic methods as compared to frequency response methods in terms of better transient response, settling time and minimum energy gain values on experimental setup. [Undergraduate Thesis](#)

State estimation in Networked Control Systems with uncertain time delay

Jan.2018- Nov.2018

- A multiple model based estimator is derived for estimation of the control inputs through a lossy communication channel with time varying delays; A combined state space model of the network and actuator is formulated
- IMM-based estimator with Kalman Filter approach is designed and validation is done using Monte-carlo simulations for an inverted pendulum system where a network delay is taken between sensor and the estimator.

Malicious node detection in wireless sensor networks using an Auto-regressive predictor and Kalman filter Jan.2017-Jan.2018

- Malicious node is detected in a wireless sensor network by comparing at each moment the difference between sensors output with estimated value by predictor and predefined threshold.
- Sensor network is considered in a propagation of a temperature wave (4th order AR model) where a corruption time moment is triggered if difference is greater than the predefined threshold.

PUBLICATIONS

- Vanshaj Khattar, Azim Eskandarian “**Stochastic Predictive Control for Crash Avoidance in Autonomous Vehicles Based on Stochastic Reachable Set Threat Assessment**” Proceedings of the ASME 2021 International Mechanical Engineering Congress and Exposition IMECE 2021. [Link](#)
- Vanshaj Khattar, Azim Eskandarian “**Reactive Online Motion Replanning for Crash Mitigation in Autonomous Vehicles using Bezier Curve Optimization**” Proceedings of the ASME 2020 International Mechanical Engineering Congress and Exposition IMECE 2020. [Link](#)
- Sudarshan K. Valluru, Madhusudan Singh, Mayank Singh, Vanshaj Khattar “**Experimental Validation of PID and LQR control techniques for stabilisation of Cart Inverted Pendulum System**” to IEEE International Conference on Recent Trends in Electronics, Information and Communication Technology 2018.
- **Abstract submission** - Sujith Vijayan, Aashit Shah, Vanshaj Khattar “**Effects of Opioids on Intracranial EEG-Frequency distribution and Phase coupling in various brain regions**” to American Academy of Neurology 2021
- **Under Review** - Vanshaj Khattar, Azim Eskandarian ”**Stochastic Reachable Set Based Threat Assessment for Autonomous Vehicles using Trust Based Driver Behavior Prediction**” [Link](#)

AWARDS AND SCHOLARSHIPS

- Second position in 2021 Paul E. Torgersen Graduate Student Research Excellence Award for MS Oral Presentations

INDUSTRIAL INTERNSHIPS

Central Electricity Authority of India

May 2017-August 2017

- Ensured optimal steady state operation of Radial distribution systems using dynamic programming

BSES Power Distribution company

Dec. 2016 - Jan. 2017

- Worked on testing procedures of transformers and ring main units and conducted offline and online tests to ensure the healthiness of the transformers and ring main units.

TECHNICAL SKILLS

Programming Languages: Python, C, C++,

Other Tools MATLAB, OpenAI Gym, PyTorch, NumPy, SciPy, Latex, CARLA