Abhay Singh Bhadoriya

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EDUCATION

Ph.D. Candidate, Mechanical Engineering Texas A&M University**,** College Station, TX Exp Grad - Aug2024

Thesis: Assisted Path Planning for Heterogenous Agents with Structural and Motion Constraints

*Key Courses***:** Analysis of Algorithms, Data Structures, Combinatorial & Heuristic Optimization, Survey of Optimization, Mathematical Modelling, Robotic Manipulators, Design of Non-Linear Control Systems

B. Technology, Chemical Engineering Indian Institute of Technology, Bombay, India Aug 2017

RESEARCH PROJECTS

Assisted Path Planning in an Impeded Environment May 2020-Dec 2023

Funding: Air Force Research Laboratory, US

- Developed a **Multi-Agent Path Planning** algorithm with ***asynchronous*** robot motion for complex applications, such as warehouse operations or an emergency vehicle escort, where an assisting agent can help the primary agent to complete a given task in a deterministic environment; **Monte-Carlo Tree Search** (MCTS) based anytime algorithm is also developed to find a near-optimal solution with limited computation time.
- For the stochastic environment, we developed an efficient **real-time algorithm** for the primary agent by combining the ***k*-shortest path** planning algorithm and ***D*Lite*** algorithm; also solved a **Rural Postman Problem** with Time Window constraints for the assisting agent path.

Object Detection and Tracking for Autonomous Vehicles Sept 2019-Aug 2020

Funding: SAFE-D, US Department of Transportation

- Develop a novel **real-time tracking system** for autonomous vehicles using Modified Multiple Hypothesis Tracking (MHT) and *YOLOv3* for **object detection** during challenging weather conditions (night-time, direct sun glare, fog) improving over baseline model by 52%.
- Developed a **sensor fusion algorithm** to combine the data from radar and 5 thermal cameras to achieve a robust 180^{o} field of view.

A Hierarchical Network for Trajectory Proposals Jul 2018-Feb 2019

- Developed a generalized two-stage *Convolutional Neural Network* architecture that mimics human ability to map the perceived surroundings to multiple trajectories for an autonomous vehicle; evaluated the framework on several platforms including KITTI dataset and indoor robots.
- Showcased the results on an in-house drive-by-wire car with LiDAR for **mapping** and Real-Time Kinematic-GPS and IMU for **localization**.

WORK EXPERIENCE

Autonomy Intern, Fox Robotics, Austin, TX May 2024-Present

- Analyzed intervention data for a fleet of autonomous forklifts from various customers and designed a high-frequency local planner to actively avoid static and dynamic obstacles on the warehouse floor, **improving the throughput rate** by **16%** while ensuring safety.
- Implemented the local planner using the Model Predictive Path Integral (MPPI) algorithm to work alongside the global planner.

Graduate Student Researcher, Los Alamos National Laboratory, Los Alamos, NM Jan 2024-May 2024

- Formulated a novel Multiple Traveling Salesman Problem (MTSP) with fairness constraints as a **Mixed-Integer Second Order Cone** program, a computationally efficient alternative to state-of-the-art min-max MTSP; developed a custom branch-and-cut algorithm to solve it optimally.
- Proposed a framework for the trade-off analysis between efficiency vs safety in an autonomous platoon under emergency braking maneuvers with uncertain breaking capacity; Developed a **Temporal Normalizing Flow Neural Network** to estimate the collision probability.

Electronics and Powertrain Engineer, Vazirani Automotive, Mumbai, India Jul 2017-May 2018

- Developed a 600 kW electric powertrain for the Vazirani Shul electric hypercar including the inhouse battery management system (BMS).
- Designed a 3kW cooling system for power-dense lithium-ion battery, including two-phase immersion cooling and phase change material.

SKILLS & CERTIFICATIONS

- **Programming**: C++, Python (PyTorch, TensorFlow, Pandas, NumPy, SciPy), Kotlin, Java, Julia, SQL, MATLAB, Latex
- **Algorithms**: Dijkstra, A*, M*, D*lite, Conflict Based Search (CBS), Rural Postman Problem (RPP)
- **Software**: Git, CUDA, Robot Operating System (ROS), CPLEX, Gurobi, Solidworks
- **Skills:** Numerical Optimization, Model Predictive Control, Nonlinear Programming, Probability Theory, State Estimation, Combinatorial and Stochastic Optimization, Graph Theory, Deep Learning, Reinforcement Learning
- **Certifications:** Machine Learning, Deep Learning Specialization, Object-oriented Data Structures in C++

PUBLICATIONS & AWARDS

- Bhadoriya, Abhay Singh, et al. "Optimal Path Planning for a Convoy-Support Vehicle Pair Through a Repairable Network." **IEEE Transactions on Automation Science and Engineering** (2023).
- Bhadoriya, Abhay Singh, Vamsi Vegamoor, and Sivakumar Rathinam. "Vehicle Detection and Tracking Using Thermal Cameras in Adverse Visibility Conditions." ***Sensors*** 22.12 (2022): 4567.
- **Reviewer**: Journal of Intelligent and Robotic Systems, Transactions on Intelligent Transportation Systems, Journal of Aerospace Information Systems, International Conference on Robotics and Automation.
- **Research Fellowship**: Emil Buehler Aerodynamic Analog Fellowship and Summer Research Fellowship.
- **Institute Roll of Honor:** Awarded for Innovative Design in IIT Bombay Racing.