# Keshav Bagri

bagri.5@osu.edu | LinkedIn | Website

## Education

**The Ohio State University** — **Columbus, OH**
*Master of Science in Mechanical Engineering [GPA: **4.0/4.0**]* — *2022 – 2024*
*Graduate Specialization in Automotive Systems and Mobility*
***Thesis**: Quantitative risk assessment and mitigation through fault diagnostics for automated vehicles*

**Indian Institute of Technology (IIT) Kharagpur** — **Kharagpur, India**
*Bachelor of Technology (Hons.) in Mechanical Engineering [CGPA: **9.26/10**]* — *2018 – 2022*
*Micro Specialization in Embedded Control, Software, Modelling and Design [CGPA: **9.5/10**]*
***Thesis**: Fault tolerant control system for Electric Vehicles*

## Publications and Peer-reviewed conferences

- Singh, Y., **Bagri, K.**, Jayakumar, A., Rizzoni, G. Fault Diagnostics for Oscillatory Failure Case in Aircraft Elevator Servos. IFAC World Congress in Yokohama, Japan, July 2023. [Link]
- Peer reviewer (upon invitation) for 2024 **American Control Conference** (ACC) held in Toronto, Canada and 2024 **Modeling Estimation and Control Conference** (MECC) held in Chicago, Illinois.

## Awards and Achievements

- $2^{nd}$ **place** in "Aerospace Competition on Fault Detection & Fault Tolerance" at **IFAC World Congress 2023** by **Airbus**
- **Gold Medal** in Inter IIT Tech Meet 10.0 (2022) in the event "Powered Bonnet for EVs" by **Jaguar Land Rover India**
- **1st place** in Combustion category & Engineering Design among **31 teams** globally at Formula Bharat Virtuals 2021-22
- **Gold Medal** in Inter IIT Tech Meet 9.0 (2021) in the event "Bosch's Electric Vehicle Simulation" by **Robert Bosch India**

## Research Experience

**Fault tree analysis** — **The MathWorks Inc.**
*Software Developer | [Simulink Fault Analyzer]* — *May 2023 – August 2023*
- Engineered the **full stack development** of a feature to analyze fault trees, reducing safety engineers' workload by **50%**
- Incorporated functionalities to enable the precise determination of **failure probability** & identification of **minimal cut sets**
- Recognized limitations in the existing implementation, proposing actionable solutions to improve the efficiency by **30%**

**Planning & controls stack for SAE Level 4 autonomy** — **The Ohio State University**
*General Motors - SAE AutoDrive Challenge II | [Center for Automotive Research]*

*Graduate Research Associate | Advisor: Prof. Giorgio Rizzoni* — *August 2023 – August 2024*
- Developed an optimal graph-based dynamic rerouting algorithm, enabling real-time on-demand computation of a new trajectory for obstacle avoidance in an urban driving environment, ensuring efficient navigation towards the global goal
- Devised a Finite State Machine - based behavior planner for navigation in an urban environment using object and traffic sign detections for decision-making and collision avoidance
- Coordinated with the systems safety, perception, & CAN teams to develop testing scenarios, considering key requirements

*Co-Lead, Planning & Controls team* — *August 2022 – May 2023*
- Devised a polynomial-interpolation-based **trajectory generation** module to sample waypoints for lane change maneuver
- Formulated the logic for **lane changing maneuver** in a highway environment & performed SIL testing for edge cases
- Assisted in formulating the **Functional Interface Analysis** & Requirements Traceability Matrix, ensuring safety compliance

**Robust translation for Scenario Description Language** — **WMG, University of Warwick**
*Research Collaborator | [Intelligent Vehicles]* — *January 2022 – July 2022*
- Developed the Java-based translation framework between levels of **Scenario Description Language** for ADS simulation
- Formulated the mapping between environmental features and language variables using the taxonomy defined in **PAS 1883**
- Defined the boundary conditions for the agents' maneuver to describe the **Synchronised Serial Maneuver Sequences**

**Control algorithms for a Hybrid Mobility Robot** — **Revolute Robotics**
*Controls Engineer | [Revolute Robotics]* — *March 2022 – July 2022*
- Modified the **min. jerk trajectory** planner for smooth navigation using a dynamic window of **3 waypoints** per time step
- Formulated the cost-based **path planning & obstacle avoidance** approach using min. jerk planner & A* search algorithm
- Identified multiple methods to enable **data-logging** over cloud from the flight controller thus reducing manual intervention

**Performance assessment of Driver-in-Loop simulators** — **The Ohio State University**
*Advisor: Dr. Jeffrey P. Chrstos | [Center for Automotive Research]* — *February 2021 – March 2022*
- Reviewed literature for absolute and relative validity of medium fidelity D-i-L simulators for **physical validation**
- Proposed the **testing methodology** for the simulator's platform's motion and analyzed the results in the essence of OMCT
- Utilized the output of **LVDTs** for multiple displacement inputs to compute the platform's roll & pitch angles using MATLAB

**SLAM for autonomous cargo delivery vehicles** — **Ati Motors, Bengaluru**
*Autonomy team* — *November 2020 – January 2021*

- Explored multiple **SLAM algorithms** like IMLS, EKF, Gmapping, etc. to select an efficient method for implementation
- Implemented the **Particle Filter** SLAM algorithm to build maps on a 2D grid using lidar and wheel odometry in Python
- Analysed the effects of multiple **resampling algorithms** and variation in **hyperparameters** on the map's quality

**Motion planning for autonomous vehicles** — **ARMS Lab, IIT Bombay**
*Advisors: Prof. Leena Vachhani and Prof. Arpita Sinha | ARMS Lab* — *July 2020 – October 2020*

- Formulated the **Markov Decision Process** representation for the agent considering different state and action spaces
- Generated training datasets for a **RL model** for the safe traversal of the vehicle in a **non-signalized** environment
- Developed a **Finite State Machine** for lane following & 2-way lane intersection (without traffic signals) management

## Projects

**Powertrain development | TeamKART, Formula SAE | [Website]** — **IIT Kharagpur**
*Supervisor: Prof. Dhananjay Kumar Srivastava* — *June 2019 – August 2021*

- Designed the **fuel tank** and the mounting arrangement for the vehicle considering the optimal capacity requirement
- Designed and analyzed the components of the **transmission** and **cooling system** for a standard FSAE electric vehicle
- Engineered the **intake manifold** & **crossflow radiator** for a single cylinder engine, producing a power output of **35 HP**
- Performed **engine simulations** in Ricardo WAVE and **CFD analysis** using Ansys Fluent for designing the intake manifold

**Fault tolerant control system for electric vehicles** — **IIT Kharagpur**
*Supervisor: Prof. Somnath Sengupta | Advanced Technology Development Center* — *February 2021 – April 2022*

- Worked on the modeling of integrated **ABS & regenerative braking** for efficient braking & maximum energy recuperation
- Engineered a **non-linear state estimator** using vehicle dynamics' equations to generate estimates of the vehicle's conditions
- Designed a novel **constraint-aware PI - sliding mode controller** for regulating the stability under all driving conditions
- Explored the possibility of integrating the novel controller with **reconfigurable control allocator** for fault-tolerant control

**Mathematical modelling of Li-ion batteries focusing on Si anode particles** — **IIT Kharagpur**
*Supervisor: Prof. Jeevanjyoti Chakraborty | Mechanical Engineering Department* — *February 2020 – January 2021*

- Studied the mechanics behind **crack development** and formation of amorphous lithiated Si with time around the Si anode
- Solved Ordinary and Partial differential equations, using **Finite Difference & Liebmann's methods**, in Python
- Established a **two-way coupling** relation between diffusion & stress, to understand the effect of one parameter on the other

**Deep reinforcement learning for autonomous vehicles** — **IIT Kharagpur**
*[Description] | Github* — *August 2020 – September 2020*

- Deployed a **Dueling DNN** to predict discrete action values & mapped them to continuous signals for vehicle control
- Used **84x84 RGB** images for the environment perception as the state information collected from the camera sensor
- Accommodated the wheel odometry, collision & lane invasion sensor data to compute **real-time reward** for the agent

## Coursework / Technical Skills

**Programming**: C/C++, Git, Python, MATLAB, LaTex, Arduino, ROS, Atmel Studio

**Softwares**: MATLAB/Simulink, CARLA Simulator, Gazebo, COMSOL

**Coursework**: Powertrain control, Autonomy in Vehicles, Fault diagnosis, Vehicle dynamics & control, Linear Systems Theory

## Teaching & Volunteering Experience

**College of Engineering** — **The Ohio State University**
*GUIDE Peer Mentor* — *August 2023 – April 2024*

- Responsible for assisting fresh graduate students in navigating the university by guiding them about university resources

**Department of Mechanical & Aerospace Engineering** — **The Ohio State University**
*Graduate Teaching Associate* — *January 2023 – May 2023*

- Courses: ME 3751 (Kinematics & Mechanism Design) and ME 3670 (Design & Analysis of Machine Elements)
- Responsible for conducting weekly recitations, office hours and doubt clarification sessions for a batch of 60+ UG students

## Leadership Experience

**Captain** — **The Ohio State University**
*SAE - General Motors AutoDrive Challenge II* — *May 2023 – June 2024*

- Leading a team of 20+ students from Ohio State to prototype the hardware & software stack for SAE Level 4 autonomy
- Responsible for coordinating with different sub-teams to establish the pipeline, in accordance with project requirements

**Deputy Team Leader** — **IIT Kharagpur**
*TeamKART, Formula SAE* — *July 2020 – August 2021*

- Leading a dedicated team of **47** students towards the research & development of Formula Student prototype vehicle
- Prepared the design & manufacturing timeline and procurement plan to ensure a smooth & efficient workflow for project **K6**