# Keshav Bagri

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#### EDUCATION

#### The Ohio State University

Master of Science in Mechanical Engineering [GPA: 4.0/4.0]

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

Bachelor of Technology (Hons.) in Mechanical Engineering [CGPA: 9.26/10] 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<sup>nd</sup> 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

Software Developer | [Simulink Fault Analyzer]

- ◇ 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
- $\diamond$  Recognized limitations in the existing implementation, proposing actionable solutions to improve the efficiency by 30%

# Planning & controls stack for SAE Level 4 autonomy

SAE - General Motors AutoDrive Challenge II | [Center for Automotive Research]

Graduate Research Associate | Advisor: Prof. Giorgio Rizzoni

- ♦ 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

- ◇ 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**

Research Collaborator | [Intelligent Vehicles]

- ♦ 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

Controls Engineer | [Revolute Robotics]

- ♦ 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

Advisor: Dr. Jeffrey P. Chrstos | [Center for Automotive Research]

- ◇ 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

# The Ohio State University

#### August'23 – Present

August'22 – May'23

#### WMG, University of Warwick

January'22 - July'22

**Revolute Robotics** 

March'22 – July'22



The Ohio State University

February'21 – March'22

Columbus, OH

August'22 - August'24

Kharagpur, India July'18 - May'22

The MathWorks Inc. May'23 - August'23

## SLAM for autonomous cargo delivery vehicles

Autonomy team

- ♦ 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 of autonomous vehicles

Advisors: Prof. Leena Vachhani and Prof. Arpita Sinha | ARMS Lab

- ◇ 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]

Supervisor: Prof. Dhananjay Kumar Srivastava

- ♦ 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

- Supervisor: Prof. Somnath Sengupta | Advanced Technology Development Center
  - ♦ 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 Supervisor: Prof. Jeevanjyoti Chakraborty | Mechanical Engineering Department

- 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 [Description] | Github

- August'20 September'20 ♦ 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**

GUIDE Peer Mentor

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

# Department of Mechanical & Aerospace Engineering

Graduate Teaching Associate

♦ 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

SAE - General Motors AutoDrive Challenge II

♦ 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** 

TeamKART, Formula SAE

- ♦ 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

The Ohio State University August'23 – April'24

# The Ohio State University

January'23 – May'23

May'23 - June'24

**IIT Kharagpur** 

July'20 – August'21

The Ohio State University

**IIT Kharagpur** February'20 - January'21

**IIT Kharagpur** 

**IIT Kharagpur** 

February'21 - April'22

Ati Motors, Bengaluru November'20 – January'21

ARMS Lab, IIT Bombay

July'20 - October'20

**IIT Kharagpur** 

June'19 – August'21