

Sai Madhavan Surabathula

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Education

Johns Hopkins University

M.S.E - Mechanical Engineering: Robotics, Systems Modeling, Dynamics, and Control

August 2022 – May 2024

Maryland, USA

Mahindra University

Bachelor of Technology in Mechanical Engineering

August 2016 – September 2020

Telangana, India

Experience

ELTRA Electric Trailers

Founding Project Engineer - Mechatronics

March 2024 – January 2025

San Francisco, CA, USA

- Designed and built the first **full-scale prototype of the Electric Pusher Trailer Unit**, enabling extended EV range and alleviating range anxiety.
- Led the **design and FEA analysis** of the vehicle frame in Onshape, procured a Ford F-150 axle, UQM motors, and BorgWarner differential, and integrated them with **custom components** sourced from a CODA EV.
- Developed a **low-voltage system** to power peripherals, including the VCU, BMS, cooling, sensing, and signaling systems.
- Engineered a **custom cooling system** to ensure optimal thermal management of drivetrain and battery components.
- Fabricated and integrated a **custom battery enclosure**, adhering to safety standards comparable to Tesla battery packs.
- Developed a **CAN sniffer** to tap into communication between the VCU and inverter, setting the foundation for future VCU replacement, and **spoofed throttle signals** for VCU testing, enabling remote control via SSH to an onboard server.
- Conducted **MATLAB modeling and sensitivity analysis** to simulate real-world conditions and guide the procurement of critical components, including motors, inverters, and BMS, which were subsequently validated and tested.
- Integrated core systems (**battery enclosure, VCU, BMS, and inverter-motor pair**), resolving technical challenges to achieve a initial **road-tested prototype**, with ongoing validation runs and further system refinements in progress.

Mahindra & Mahindra (Automotive R&D)

Assistant Manager - Vehicle Integration and Prototyping

March 2021 – June 2022

Pune, India

Electric Vehicle (EV) Pick-Up Truck Development

- Performed subsystem packaging for the **Electric Vehicle (EV) Pick-Up Truck Architecture [1.5–2.10 Tonne]** using CATIA, focusing on manufacturability, platform part interchangeability, and assembly line efficiency.
- Overcame supply chain constraints by integrating standardized IC vehicle parts into the EV platform, optimizing for **battery placement, thermal management, and powertrain integration**.
- Conducted benchmarking analyses and teardowns of competitor vehicles to recalibrate performance metrics and developing MATLAB algorithms to estimate **cargo weight based on engine load** and predict fuel efficiency.

P112/P113 Pickup Truck Prototype Build

- Reduced build time by over **70%** for the P112/P113 (1–2 Tonne Pick-Up Truck) mule build by resolving issues such as **brake line fouling, engine mounting misalignments, and fit-and-flush inconsistencies**.
- Led the **offline prototype build process**, coordinating manual assembly and ensuring proper documentation of critical build issues to improve **design and process efficiency** in subsequent builds.

XUV700 SUV Production Ramp-Up

- Enhanced NVH (**Noise, Vibration, and Harshness**) performance by optimizing robotic **mastic sealant application**, reducing drumming noise, and improving vibration characteristics in XUV700.
- Resolved critical door closure issues by addressing **hinge stiffness, angles, smoothness, and improper latching**, and collaborated with suppliers to optimize hinge manufacturing and adjust angles during riveting for reproducible efforts across production models.

Key Skills

- **Programming & Algorithm Development:** Python, MATLAB, Simulink, ROS, Gazebo, Rviz
- **Simulation & CAD Modeling:** Onshape, CATIA, AutoDesk Inventor, SolidWorks
- **System Integration & Testing:** Low-voltage systems, sensor fusion, CAN communication, hardware-software co-design
- **Manufacturing Process Expertise:** Supplier evaluation, component sourcing, assembly documentation
- **Rapid Prototyping & Fabrication:** Oscilloscopes, Function Generators, Logic Analyzers, Soldering (Perf Boards, PCBs), Basic Milling & Lathe Operations, Material Selection, Resin & FDM Printers (Building, Troubleshooting, Modifying)
- **Root Cause Analysis & Problem Solving:** System failure resolution on production lines and field environments

Academic Research & Projects

Graduate Research Assistant - Dynamical Systems & Controls Laboratory **March 2023 – May 2024**
Johns Hopkins University, Whiting School of Engineering *Baltimore, MD, USA*

- Integrated sensors and actuators into the **ROS framework** for JHU ROV2, a deep-sea navigation vehicle, focusing on scalable control algorithms for extreme-depth marine conditions.
- Implemented **Extended Kalman Filters** to fuse data from Quartz Depth Sensors and Phins INS Systems for precise navigation and control.

Team Lead - Autonomous Underwater Vehicle (AUV) **August 2019 – September 2020**
Mahindra University *Hyderabad, India*

- Led the design and integration of Telangana's **first Autonomous Underwater Vehicle (AUV)**, achieving a **60% cost reduction** and completing development in **8 months**.
- Presented a paper at **OCEANS 2021: San Diego - Porto**, detailing the V-cycle model for mechanical design and integration.

Specialized Engineering Projects

Control, Estimation, & Actuation - Manipulators & Mobile Robots

- **UR5 Robot Kinematics Modeling & Simulation:** Developed a mathematical model for UR5 robot motion simulation and animation using **C++** in **RViz**, focusing on kinematics and Jacobian analysis.
- **Hand-Eye Calibration for UR5 Robot with AR Tag Detection:** Implemented hand-eye calibration for UR5 using **Frank Park's method** and MATLAB scripts for data generation and calibration accuracy; tested in simulated and real-world environments with **ROS & RViz**.
- **Probabilistic Road Map (PRM) Path Planner for UR5 Robot:** Designed a PRM path planner for UR5, developing **C++ algorithms** for vertex generation, edge computation, and graph search optimization; validated through RViz simulations and real-world testing.
- **Extended Kalman Filter Localization for Mobile Robot in Rugged Terrain:** Developed an EKF for real-time localization of a **Clearpath Robotics Jackal** in rugged terrain with Gazebo, incorporating 3D dynamic process and sensor observation models for **GPS & IMU**.
- **Particle Filter Localization for Jackal Robot in Outdoor Simulation:** Implemented a particle filter using sensor beam and odometry motion models for Jackal robot localization in a **Gazebo-simulated environment**, focusing on sensor model optimization.

High Fidelity 6DOF Fixed Wing Aircraft & UAV Model Development

- **6DOF Simulation Model Development:** Developed a **6DOF simulation model** for fixed-wing aircraft and UAVs using MATLAB, Simulink, and Flybrix hardware.
- **Dynamic System Analysis:** Used MATLAB & Simulink for dynamic system analysis, focusing on **aerodynamics, flight dynamics, and control systems**; applied trimming, linearization, and dynamic response analysis to optimize autopilot systems.
- **Controller Design:** Designed and deployed **PID & Rate Feedback controllers** for flight phase management, integrating custom autopilot algorithms.
- **Sensor Modeling:** Developed sensor models for **gyros, accelerometers, and pressure sensors** to refine UAV state estimation; implemented an **Extended Kalman Filter** for accurate attitude estimation and inertial navigation.