

# Aashish Shaju

Controls engineer specializing in feedback control, state estimation, and physics-based modeling of complex dynamic systems. Proven experience in trajectory optimization (MPC), motion planning, and control algorithm design, with hands-on validation through simulations and experiments. Skilled in integrating fundamental principles with data-driven methods to develop scalable solutions. Background includes C++, Python, MATLAB/Simulink, and translating research into deployable systems for real-world applications.

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## Research and Professional Experience

### 1. Research Associate | Center for Vehicle Systems & Safety Jan 2025 – present

#### Ultrasonic Acoustic Emission based Structural Health Monitoring

- Designed and validated a real-time DAQ and signal-processing pipeline (MATLAB + embedded C++) for high-frequency ultrasonic measurements
- Built custom analog signal-conditioning circuits (amplifiers, filters) to interface sensors with embedded hardware, ensuring high signal-to-noise ratios for reliable data analysis
- Implemented classification tools using feature extraction and machine learning (DES Random Forest) to interpret sensor data and enhance diagnostic accuracy

### 2. Graduate Research Assistant | Virginia Tech (Ph.D.) Aug 2021 – Dec 2024

- Developed physics-based dynamic models for articulated vehicle systems using TruckSim and Simulink, enabling analysis of nonlinear and coupled system behavior
- Designed and evaluated feedback control algorithms for autonomous systems, including integrated longitudinal-lateral controllers (clothoid-based trajectory tracking)
- Performed stability, robustness, and sensitivity analyses through large-scale simulations to assess controller performance across operating conditions
- Validated control designs through software-in-the-loop workflows, emphasizing scalability and reproducibility

### 3. Research Assistant | Vibration Research Lab, IIT Delhi Sep 2020 – July 2021

- Conducted NVH (Noise, Vibration, and Harshness) and acoustic analysis to support the development of a Health & Usage Monitoring System (HUMS) for military vehicles
- Optimized sensor placement and extracted spectral and statistical features from vibration data (accelerometers) to build diagnostic models for vehicle subsystems (suspension/powertrain)

### 4. Graduate Research Assistant | IIT Hyderabad (MS) Aug 2018 – June 2020

- Modeled tire-road interaction forces and implemented the model in CarSim–Simulink co-simulation, running targeted simulations to evaluate handling, stability, and transient-steady-state discrepancies

## Selected Technical Projects

- **MPC-Based Trajectory Tracking:** Developed an MPC framework for a nonholonomic tractor-trailer system, incorporating system constraints and robustness analysis, validated on complex reference paths
- **Multi-Sensor Nonlinear State Estimation for Robotic Platforms:** Developed and benchmarked EKF and UKF for a nonlinear tricycle robot, modeling stochastic steering and velocity via Markov processes and fusing multi-station radar measurements for real-time localization and state estimation

## Publications (Selected)

1. Shaju, A., et al. "Passive Air-Coupled Ultrasonic Sensors for Wheel Crack Detection." Sensors, 2025 <https://doi.org/10.3390/s25196126>
2. Shaju, A., Southward, S., Ahmadian, M. "Clothoid-Based Lateral Control for Autonomous Vehicles." Applied Sciences, 2024 <https://doi.org/10.3390/app14051817>
3. Shaju, A., Southward, S., Ahmadian, M. "PID-Based Longitudinal Control of Platooning Trucks." Machines, 2023 <https://doi.org/10.3390/machines11121069>
4. Shaju, A., Pandey, A. "Transient Response Modeling Using PAC2002 Tire Model." Vehicle System Dynamics, 2020 <https://doi.org/10.1080/00423114.2020.1802048>

## Education

### Virginia Tech

Ph.D. Mechanical Engineering

*Timeline: Aug 2021 - Dec 2024*

GPA: 4.0/4.0 ([Thesis link](#))

### IIT Hyderabad

M.S. Mechanical Engineering

*Timeline: Aug 2018 - May 2020*

GPA: 3.8/4.0 ([Thesis link](#))

### Cochin University of Science and Technology

B.S. Mechanical Engineering

*Timeline: Aug 2013 - May 2017*

GPA: 3.6/4.0

## Quantitative and Technical Skills

### Control & Estimation

PID, LQR, MPC, adaptive control, Kalman filtering, state-space modeling

### Modeling & Simulation

MATLAB/Simulink, TruckSim, CarSim, multibody dynamics, ADAMS, CAD (NX, Catia, SolidWorks), CAE (Ansys, Abaqus)

### Estimation & Data

Kalman filtering, system identification, signal processing, feature extraction, Machine Learning (Random Forest, DES)

### Programming

C++, Python, Embedded C++, Git, Real-Time DAQ, Sensor Integration

### Experimentation

Real-time DAQ, sensor integration, analog signal conditioning, experimental design

## Awards & Honors

**Plenary Presentation:** IAVSD 2025 (Vehicle Dynamics Conference)

**Pratt Fellowship (Virginia Tech):** 2022 for academic achievement