Sai Pranav Avva

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EDUCATION

Johns Hopkins University Aug 2024 – Aug 2026
Master of Science in Mechanical Engineering Baltimore, MD

TECHNICAL SKILLS

- **Robotics & Control:** ROS2, Inverse Kinematics, Path Planning on 3D Point Cloud (PCL), Motion Planning, PID Control.
- **Medical Imaging Systems:** 3D Slicer, MRI-Compatible Design, Image-Guided Interventions, Optical Tracking (Atracsys).
- **Design & Analysis:** SolidWorks, Fusion 360, FEA (COMSOL, ANSYS), MATLAB/Simulink, Rapid Prototyping.
- **Embedded Systems :** Python, C/C++, Arduino, ESP32, PCB Design, TensorFlow, OpenCV, YOLO, Sensor Integration, Git.
- **Manufacturing:** 3D Printing, MEMS Fabrication, CNC Machining, Carbon Fiber Composites, Wire Harnessing.

PROFESSIONAL EXPERIENCE

Graduate Researcher - Medical Device Design (IMERSE Lab) Aug 2025 – Aug 2026
Johns Hopkins University, Whiting School of Engineering Baltimore, MD

- Engineering a tetherless, multiphysics soft-robotic gripper that couples magnetic actuation with a bistable compliant shell to passively grasp irregular tissue geometries (e.g., colonic/rectal polyps) without onboard motors or power.
- Designing the gripper around compliant shell bistability principles to decouple tissue-gripping energy from external actuation, enabling a passive, self-contained grasping behavior validated across multiple clinically representative phantom geometries.
- Conducting scaling analysis of the compliant bistable mechanism to demonstrate that structural performance is geometry-driven , stablishing a design pathway toward capsule-scale miniaturization for clinical deployment.

MEMS Engineer - Navigational Sensors Jun 2022 – Jul 2024
Indian Institute of Science & Indian Space Research Organization Bangalore, India

- Designed high-precision MEMS inertial sensors (accelerometer and disk resonator gyroscope) achieving 0.001 deg/hr resolution through parametric optimization and electrostatic actuation.
- Performed multiphysics COMSOL simulations (electro-mechanical coupling, modal and frequency response), achieving <5% eigenfrequency error between simulation and fabricated devices.
- Designed MEMS layouts and generated Clewin/KLayout fabrication files and co-authored a peer-reviewed conference paper validating end-to-end model-to-hardware precision sensing performance (ICMNS 2024).

Electronics Consultant- Biomechanical Data Acquisition System Aug 2023 – Aug 2024
Translead MedTech Private Limited Bangalore, India

- Defined and executed a quantitative evaluation framework for a customizable assistive chair during sit-to-stand motion for elderly users.
- Implemented a biomechanical data acquisition system using EMG and IMU sensors to capture muscle activation and body kinematics.
- Conducted human-in-the-loop testing and baseline comparisons, demonstrating a 10% reduction in user effort during transitions.

IoT Engineer - Micro-Mobility Vehicle Electronics Dec 2021 – May 2022
Delta X Automotive Bangalore, India

- Developed an ESP32-based embedded control system implementing biometric locking and anti-theft features.
- Designed a custom PCB for power management and integrated motors, battery, and mechanical subsystems to deliver a functional vehicle minimal viable prototype for on-road testing.
- Implemented PID motor control with regenerative braking and CAN-based tuning to achieve a 50 km operating range and co-invented an Indian patent for biometrics-based electric vehicle operation.

Mechatronics Engineer - Laboratory Automation Sep 2021 – Dec 2021
Anand Diagnostic Labs Bangalore, India

- Developed a 4-DOF robotic arm for automated test tube sorting, increasing laboratory throughput by 40% using vision-guided pick-and-place with an RGB camera and YOLO-based object detection
- Implemented an embedded control and vision pipeline integrating camera feedback with real-time trajectory execution to enable safe, repeatable pick-and-place motion in a human-accessible laboratory environment.
- Engineered a custom worm-gear transmission (NEMA 17/23) delivering 233 kg·cm torque at a total system weight under 13 kg, with vision-based human limb detection triggering real-time motor cutoff and emergency stop logic.

PATENTS & PUBLICATIONS

- **Patent:** Navaz Z., Venkatesh K., Logasrinivasan P., Harit T., and **Sai Pranav A.** "System and Method for a Biometrics-based Operation of Electric Vehicles." Delta X Automotive Private Limited, Indian Patent No. 202241046561, filed August 16, 2022 (Pending)
- **Conference Paper: Sai Pranav Avva**, Suman Acharya, Kandula Eswara Sai Kumar, Sudhanshu Shekar, Karthik Raveendranath, and G K Ananthasuresh. "A Novel Accordion-like Disk Resonator Gyroscope." *International Conference on Micro, Nano, and Smart Systems (ICMNS)*, July 11, 2024

ACADEMIC PROJECTS

Robotic Assistant for MRI-Guided Low Back Pain Injections Sep 2024 – May 2025
Johns Hopkins University, Computer-Integrated Surgery II Baltimore, MD

- Led finite element analysis in ANSYS to redesign 3D-printed and carbon fiber robot linkages, doubling structural rigidity while maintaining MRI compatibility and five-DOF kinematic constraints for lumbar spinal injections.
- Developed and executed micron-level accuracy validation using dial indicators and optical tracking to quantify bidirectional end-effector and needle tip positioning error during remote center of motion maneuvers.
- Designed an MRI-table-compatible lower-body harness and fiducial mounting system to securely position the lumbar injection robot while accommodating patient variability and enabling rapid emergency detachment.

Haptic-Guided Magnetic Microrobot Navigation for Maze-Like Environments Sep 2024 – Dec 2024
Johns Hopkins University, Haptic Interface Design Baltimore, MD

- Designed and implemented a haptic-feedback control framework for magnetically actuated microrobots navigating a petri-dish maze.
- Integrated a custom wall-detection algorithm with MATLAB-based joystick haptics and electromagnetic coil control, encoding collision proximity and persistence into graded vibration feedback.
- Evaluated the system in a four-participant user study, using qualitative feedback to tune haptic thresholds and feedback profiles to identify enhancements for robust camera-free navigation.

MRI-Guided Lumbar Spine Needle Insertion Robot – Targeting and Path Planning Oct 2024 – Nov 2024
Johns Hopkins University, MRI Compatible Robotics Baltimore, MD

- Developed a vision-based neural network control system using a feedforward neural network (FNN) to enable 4-DOF soft robotic catheter navigation for lung biopsy applications.
- Implemented a ROS-based control and data acquisition pipeline with camera-based marker tracking and a custom illuminated enclosure for robust visual sensing.
- Expanded the robot workspace by integrating a Maxon rotary actuator with a NEMA-17 linear stage and trained a neural-network kinematic model to predict joint angles from pump displacement and actuation direction.
- Collected and curated over 2,200 experimental trajectories to train and validate the model, characterized dominant error sources, and proposed safety-focused improvements including pressure sensing and model-predictive control.

MRI-Guided Soft Robotic Catheter for Lung Biopsy Navigation Sep 2024 – Dec 2024
Johns Hopkins University, Medical Robot System Design Baltimore, MD

- Developed a vision-based neural network control system using a feedforward neural network (FNN) to predict joint angles from pump displacement and actuation direction, enabling 4-DOF soft robotic catheter navigation for lung biopsy applications.
- Implemented a ROS-based control and data acquisition pipeline with camera-based marker tracking for closed-loop catheter control
- Expanded the robot workspace by integrating a Maxon rotary actuator with a NEMA-17 linear stage to enable coordinated motion.
- Collected and curated over 2,200 experimental trajectories to train and validate the model, performing error analysis to identify dominant noise sources
- Characterized key error contributors including temperature-dependent stiffness, piston repeatability, and actuator limits, and proposed system-level improvements such as pressure sensing and model-predictive control for safer operation.

Semi-Autonomous Robotic Ultrasound Scanning with UR5e and RealSense Sep 2024 – Dec 2024
Johns Hopkins University,Medical Robot System Design Baltimore, MD

- Designed and implemented a ROS2-based semi-autonomous ultrasound system using a UR5e and RealSense camera, performing fundamental transducer motions (rock, fan, slide, sweep) on anthropomorphic contours.
- Developed a point-cloud processing and control stack with a Tkinter/RCLPY GUI to enable free-space and contour-constrained probe motion with user-selectable speeds.
- Implemented combined offset- and force-based position control using KDL inverse kinematics and UR5e force sensing to maintain stable probe contact while following curved anatomical surfaces.
- Validated system performance through angular and force error analysis on 3D-printed wedges, torso, and hydrogel phantoms, demonstrating accurate contour following and consistent contact force during scanning.

Biomimetic Hummingbird: Wing Kinematics & Mechanism Design Aug 2021 – Aug 2022
PES University, Bachelors Thesis Bangalore, India

- Engineered a hummingbird-inspired flapping-wing mechanism by synthesizing a modified four-bar linkage that converts continuous motor rotation into ±60° wing rocking at 70 Hz, verified through position, velocity, and acceleration plots.
- Integrated mechatronic subsystems by approximating electronics mass (IMU, GPS, RF, microprocessor, coreless motor, Li-Po battery) to size the actuator and flapping wing such that the system can generate sufficient lift for an 80–100 g prototype.
- Performed coupled aerodynamic–mechanism analysis using CAD and CFD to tune wing geometry and angle of attack (10–15° range) so that flapping frequency, aspect ratio, and wing area satisfy the frequency-induced lift model for stable hover.