

# Abhishek Joshi

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## RESEARCH INTERESTS

I focus on non-linear model and learning-based control systems, particularly their applications in safe and adaptive assistive robots for Human-Robot Interaction (HRI) in extraterrestrial environments. I am also keen on developing robust control architectures that ensure safety and autonomy in unpredictable, dynamic conditions during space missions.

## EDUCATION

B.Tech, Symbiosis University of Applied Sciences, Indore  
8.95 CGPA

2023

Relevant Coursework:

## EXPERIENCE

### **Senior Project Technical Assistant, e-Yantra, ERTS Lab, IIT Bombay**

August '23 – present

- Robotics Developer for the e-Yantra Project. Mechatronic design and software development for research projects done at the lab. Individual and collaborative research projects in robotics.
- Contributed for development of Control Systems MOOC on LQR control technique.
- Developer for cart-pole pendulum-based self-balancing robot with gripper arm attached for the theme “*Balanced Builder Bots*” in e-Yantra Robotics Competition (eYRC) 2024-25.
- Developer for an autonomous robot “*Vanguard*”, and mentor for the theme “*GeoGuide*” in e-Yantra Robotics Competition (eYRC) 2023-24. Implementing Machine Learning with Embedded Systems, GIS, and Image Processing for effective arena navigation.
- Developer and mentor for the ROS and multi-robot-based theme “*Hologlyph Bots*” in e-Yantra Robotics Competition (eYRC) 2023-24.
- Leading research projects and mentoring undergraduate students under the summer internship program.
- Conducting workshops on embedded systems for college faculties across India.

### **Summer Research Intern, e-Yantra, ERTS Lab, IIT Bombay**

May '23 – July '23

- Design and development of control systems-based research project (eCube).
- Collaborated within a team to create a pitch deck outlining potential enhancements for e-Yantra's outreach initiatives.

### **Intern, Volvo Eicher Commercial Vehicles Ltd., Technology Center (R&D Dept.), Pithampur**

June '22 – December '22

Worked on Digital Twin, data analytics, telematics, connected vehicles, EV, and ADAS projects, contributing to advanced vehicle technology development. Conducted research and development activities, enhancing vehicle performance and connectivity through innovative solutions and data-driven insights.

### **Intern, Delite Automac Pvt. Ltd., Pithampur**

July '21 – September '21

Provided 2D drawings for machining of spare automotive parts. Achieved hands-on experience on various machining tools like lathe, power press, hydraulic press, shearing, and bending machines. Contributed in production efficiency improvement planning for the manufacturing plant.

## PROJECTS

### **Motion Capture System**

May '24

Title: Realtime Motion Capture System (MoCap)  
Tech Stack: Computer Vision, Control Systems, ROS2, Python, CAD Modelling  
Hardware: High-speed Cameras, Quadcopters, IR LEDs

**Description:** A low-cost motion capture system that can track and record spatial movements of multiple objects using IR-based markers and up to 4 cameras. The output data rate is up to 40Hz at 1080p and 70Hz at 720p. Pose estimation accuracy is up to  $\pm 0.5$  mm for stationary targets and  $\pm 2.5$  mm for tracking dynamic objects such as quadrotors.

**Project link:** <https://tinyurl.com/realtime-mocap>

### Autonomous Ground Robots

November '23

**Title:** ROS-based SLAM Implementation and Hardware Optimization for Small Differential Drive Robot

**Tech Stack:** ROS2, SLAM, Nav2, Embedded Systems, RTOS, Python, C++, Model Simulation (Gazebo)

**Hardware:** Mini-differential drive robot, 360° 2D LiDAR, ESP32 microcontroller

**Description:** A skid-steer drive bot that uses ESP32 to share 2D LiDAR pointCloud and Odometry data over micro-ROS for Simultaneous Localization And Mapping (SLAM) and autonomous navigation. FreeRTOS on the ESP32 manages UDP WiFi data transfer and sensor data processing across the ESP's two cores. Odometry-based localization was achieved with a 0.2% error while navigating across a 10x10 ft. arena at an average speed of 0.15 m/s. Autonomous Navigation in the mapped arena achieved a position accuracy of 0.2 m and orientation accuracy of 0.1 radians. An Extended Kalman Filter (EKF) was developed to fuse encoder and IMU data for noise reduction. This project was also done on 2 other versions:

- Differential drive bots with Jetson Orin Nano and Arduino UNO.
- Differential drive bot with Raspberry Pi 4B and Arduino UNO

**Project link:** <https://tinyurl.com/ros-based-rover>

### Self-Balancing Cube

May '23

**Title:** Implementation & Analysis of various Control Techniques to Balance a Cube (eCube)

**Tech Stack:** Control Systems (LQR), Embedded Systems, CAD Modelling, C++, Lua, Mathematical Modelling (GNU Octave), Robot Simulation (CopelliaSim/V-REP)

**Hardware:** ESP32 microcontroller, BLDC Motors, ICM-20948 IMU

**Description:** A cube-shaped Reaction wheel-based 3D Inverted Pendulum. LQR (Linear Quadratic Regulator) and PID control techniques were applied in Simulation followed by implementation on the physical robot to balance the cube on its Vertex and Edges.

**Future work:** Balancing the cube using learning-based methods (RL)

**Project link:** <https://tinyurl.com/e-cube>

### Autonomous Projectile Launching Robot

March '23

**Title:** Autonomous Projectile Launching Robot

**Tech Stack:** Computer Vision, Embedded Systems, Python, C++

**Hardware:** AtMega 328p microcontroller, MG995 Standard Servo Motors, Web Camera

**Description:** An automated system for target tracking and locking using visual perception from a camera. The turret is equipped with a pan-and-tilt mechanism actuated by standard servo motors. Implementation of object detection, distance calculation and tracking algorithms using Image Processing. Serial communication was established between the microcontroller and CPU.

**Project link:** <https://tinyurl.com/auto-projectile-launcher>

### Self-Balancing Bike

September '22

**Title:** Autonomous Navigation & Balancing of a 2-wheeled Bike

**Tech Stack:** Control Systems, Embedded Systems, CAD Modelling, C++, Lua Mathematical Modelling (GNU Octave), Robot Simulation (CopelliaSim/V-REP)

**Hardware:** AtMega 2560 microcontroller, BLDC Motors, MPU6050 IMU, MG90s Servo Motor, DC Motor

**Description:** A reaction wheel based mini-bike that can be balanced using the LQR control technique to balance the bike both at rest and in motion. The mathematical model of the bike is based on the principle of Inverted Pendulum. Additionally, path-planning and line following algorithms were implemented for autonomous navigation.

**Project link:** <https://tinyurl.com/balancing-bike>

### ACHIEVEMENTS & LEADERSHIP

- National Rank 5 out of 372 at e-Yantra Robotics Competition (2022-23) finals held at IIT Bombay.  
Credential ID: [7f8cc704f9db0a2865295535485bbd46cd4e9f31](#)

- Innovation Head, College Go-Kart Team, 2020-23
- Best Question Award winner at Sahodaya Bal Vigyan Competition, 2017
- Silver Medal, School Rank 2 at National Science Olympiad, 2017
- Team Leader, Robotronix Robotics Competition, 2015
- Gold Medal, School Rank 1 at International Mathematics Olympiad, 2014