

# TEJAL ASHWINI BARNWAL

✉ [tejalbarnwal.iitb23@gmail.com](mailto:tejalbarnwal.iitb23@gmail.com) | [github.com/tejalbarnwal](https://github.com/tejalbarnwal) | [tejalbarnwal.github.io](https://tejalbarnwal.github.io)

## EDUCATION

**Indian Institute of Technology Bombay** (Jul '19 - Aug '23)  
*Bachelor of Technology in Mechanical Engg, GPA: 8.22/10.0* Mumbai, India

- **Key Coursework:** Kinematics and Dynamics of Machines, Machine Design, Introduction to ML, Image Processing, Probability & Stochastic Models, Motion Planning, Design Optimization, NonLinear Control Theory

## PROFESSIONAL EXPERIENCE

**Newspace Research and Technologies** (Aug '23 - Ongoing)  
*Robotics Engineer working on vision-based autonomous drones* Bangalore, India

- Tailoring Ardupilot firmware for **precise landing** on static and slow-moving targets, integrating constant velocity-based Kalman filter and synchronizing RTCP-based frame timestamp and odometry, resulting in achieving a **precision of 20cm** for landing on stationary targets
- Involved in developing vision-based **pure pursuit** guidance algorithm for globalized drone interception of a target
- Developed a custom **geometric controller** for speeds up to 7m/s and tested it in SITL and Hardware

**Open Source Robotics Foundation(OSRF)** (May '23 - Aug '23)  
*Student Developer at Google Summer Of Code* Remote

- Contributed to **ROS2** and **Gazebo** maritime simulation repository(VRX) by refactoring to improve performance

## RESEARCH EXPERIENCE

**Vision-Based Force Estimation Paw for Legged Robots** (May '22 - May '23)  
*Guide: Prof. Kostas Alexis | Autonomous Robots Lab (ARL)* NTNU, Norway

- Prototyped an open-source **Terrain Recognition And Contact force Estimation(TRACE)** Paw for legged robots enabling vision-based force estimation and audio-based terrain classification on edge in real-time
- Experimented with classical (PCA, blob detection & **optical flow**) and machine learning-based image processing algorithms for vision-based force estimation using **Micropython & OpenMV**
- Carried out **sensor fusion** for paw orientation using accelerometer and gyroscope from LSM6DSOX IMU

## PUBLICATION

- Aleksander Vangen, **Tejal Barnwal**, Jørgen Anker Olsen, Kostas Alexis, **Terrain Recognition and Contact Force Estimation Through a Sensorized Paw for Legged Robots**, *accepted at 21st International Conference on Advanced Robotics (ICAR), 2023*

## STUDENT COMPETITIONS

**The Robotic Charging Challenge** | 11th InterIIT Tech Meet (Feb '23)  
*Worked in a team of 8 to design a robotic arm capable of autonomously charging an electric vehicle*

- **Ranked 2<sup>nd</sup>** across 23 IITs | Devised a 6-DOF robotic arm performing plug detection and move towards it
- Implemented joint space **trajectory planning** considering velocity limits using a trapezoidal velocity profile

**Vision Based Obstacle Avoidance Drone** | 9th InterIIT Tech Meet (Mar '21)  
*Worked in a team of 8 to autonomously explore static cluttered environments & land on target after detection*

- **Ranked 6<sup>th</sup>** across 23 IITs and devised a navigation pipeline with three layers of intelligence algorithms
- Developed **scan & survey pipeline** to negotiate dead ends inside ROS/Gazebo using **ArduPilot SITL**

**Intelligent Picking Robot** | Flipkart Grid 2.0-Robotics Challenge (Jun '20 - Aug '20)  
*Worked in a team of 5 on an autonomous robotic arm capable of picking and transporting items in a warehouse*

- Among the **top 2%** teams qualified for Level 3 out of 6000+ teams registered for Level 1 from all over India
- Designed a **4-DOF robotic manipulator** & visualized pick and place on RViz using **MoveIt** framework

**International Micro-mouse Challenge** | Techfest, IIT Bombay (Dec '20)  
*Simulated an autonomous bot using ROS & Gazebo to solve an unknown maze in the shortest time possible*

- Bagged **1<sup>st</sup> position** and implemented **omni-wheel** drive and PD controller to reduce steering latency
- Designed an **breadth-first search** based planning algorithm while incrementally building a maze representation

**The Hilti SLAM Challenge** | IROS'21 Workshop (Sept '21)  
*Estimated poses and motion trajectories on sequences from the given dataset recorded with handheld device*

- Comprehended visual inertial odometry and applied **ORB-SLAM3** on monocular camera and IMU sensor feed
- Calibrated for **Kannala-brandt camera model** using datasheet & IMU noise parameters using imu utils

## KEY TECHNICAL PROJECTS

---

**SeDriCa** | Unmesh Mashruwala Innovation Cell, IIT Bombay (May '21 - May '23)  
*Participating in self-drive challenge of Annual Intelligent Ground Vehicle Challenge(IGVC)' 23*

- **Led Decision-Making and Localization** sub-divisions and developed pipelines for road driving scenarios
- Implemented custom-made **Finite State Machine** based behavioural architecture using ROS1 Action Servers
- Developed vehicle sensor plugins and task-specific environments to self-drive simulation stack on Gazebo Classic

**Precision Agriculture with Quadrotors** (May '21 - Nov '21)

*Advisors: Prof. Hemendra Arya and Prof. Arpita Sinha*

*Systems and Controls Department, IIT Bombay*

- Performed autonomous **raster scan** on custom crop-field Gazebo world using **PX4 SITL** and **MAVROS**
- Implemented **sliding mode control(20Hz)** on MATLAB/Simulink & studied PX4 developer's documentation

**Institute Mess Digitization Project** | Institute Technical Council, IIT Bombay (Dec '20 - Apr '21)

*Digitized institute mess to replace mess cards with student ID Cards reducing the workload of mess workers*

- Developed an in-house product prototype to be deployed in all the institute messes used by **10k+ students**
- Conceptualized a **Master/Slave** architecture (R-Pi/ ESP32) and integrated it with RC522 **RFID** reader
- Employed **MQTT** protocol to establish communication between **Raspberry Pi 3B** and multiple ESP32s

## COURSE PROJECTS

---

**Instance Segmentation - Self Driving Cars** | Web & Coding Club (WnCC), IIT Bombay (Apr '21 - Jul '21)

- Performed transfer learning on **Mask RCNN** for vehicle detection and integrated it with **CARLA** sim
- Tailored the model for specifically **8 categories** and fine-tuned it to reduce the average loss by **50%**

**Adaptive Control of Autonomous Vehicle**

(Nov '21)

*Advisor: Prof. Srikanth Sukumar*

*Systems and Control Department, IIT Bombay*

- Implemented **dynamic 2D bicycle** model to capture vehicle motion in normal driving conditions
- Designed an **adaptive back-stepping** controller and carried out simulations using MATLAB/ Simulink

**Motion Planning with Turtle-Bot**

(Nov '21)

*Advisor: Prof. Arpita Sinha*

*Systems and Control Department, IIT Bombay*

- Implemented and validated algorithm **Bug1** and **Potential Field Algorithm** with hardware deployment

## OPEN-SOURCE CONTRIBUTIONS

---

- **OpenMV**: provides an Arduino like experience for simple machine vision tasks on camera-based modules
  - Added support for **TensorFlow-lite regression** models along with **C based** python bindings ([link1](#), [link2](#))
- **Gazeboism**: Tools and libraries for robotics applications. Home of the Gazebo simulator.
  - Helped review Garden tutorials during the **Gazebo Garden Party 2022** and got a Gazebo Hoodie ([link](#))
  - Added support simulation and rendering of **BAYER format** images ([link](#))

## TEACHING & LEADERSHIP ROLES

---

**Convener** | Electronic and Robotics Club (ERC), Institute Technical Council (May '20 - Apr '21)

*Part of a 15+ member team that conceptualizes and organizes events for tech enthusiasts in the Institute*

- Conducted club orientation and a 2-day **Arduino Basics Workshop**, attended by **100+ freshmen**
- Contributed articles on Occupancy Grid Mapping, Kalman Filter and ROS to the '**ERC Wiki repository**'
- Organised '**ER101**'- a 7 week series of sessions on design and development of a robotics manipulator
- **Delivered a talk** on Kinematics & Dynamics of a 2-DOF manipulator with MATLAB demonstrations

**Python is Cool, Kids | Student-run Summer Course**

(Summer '21)

- Volunteered to conduct a summer course for **Practical Python Programming**, consisting of interactive live lectures, assignments and guided projects, with **1000+ enrollments**

## EXTRA CURRICULAR ACTIVITIES and OTHER ACHIEVEMENTS

---

### • Cultural

- Volunteered in **Kaladarshan** (annual photography and fine arts exhibition of IITB) for ideating theme, creating art installations, road painting and contributed five sketches to be put up in exhibition
- Received training for **6 years** in **painting**, and secured distinction by Bangiya Sangeet Parishad, Calcutta
- Awarded distinction in **Kathak** by Akhil Bharatiya Gandharva Mahavidyalaya Mandal, Mumbai

### • Volunteering

- Guided two **teams of 4 freshmen** for a project based on Robotics and Image Processing for Summer
- **Delivered session** on Serial Communication Protocols in embedded systems in a summer course registered by **200+ students** with TinkerCAD simulations and framed practice assignments for better understanding