TEJAL ASHWINI BARNWAL

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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
- **Achievements**:
  - **ROS Conference 2024**, held in Odense: Global Diversity Scholar & delivered a lightning talk
  - **Open-Source Contributions**: Engaging in projects like Gazebo, Ardupilot, adding & testing features

PROFESSIONAL EXPERIENCE

Newspace Research and Technologies | Robotics Software Engineer *(Aug '23 - Ongoing)*
An aerospace based defence startup focused on military surveillance, logistics and disaster relief *Bengaluru, India*

- **Precision Landing**
  - Engineered Ardupilot precision land mode achieving **20cm accuracy** on a 5kg quadrotor using constant velocity **Kalman filtering** with ROS-synced vision/odometry on static and slow-moving target
  - Implemented custom **GStreamer** plugin for extracting absolute timestamp of image frame in RTSP Stream
- **Vision-Based Interception**: Implemented **vision-based pure pursuit** guidance for drone target interception, attaining **2.0m accuracy** at speeds up to 15 m/s on a 2kg drone
- **General Vision-Based Navigation**: Developed vision-based navigation for high-velocity fly above and markerless landings, achieving **average 6m accurate landings** from 200m and 500m altitudes on 20kg and 40kg drones
- **Geometric Controller**: Implemented and validated a throttle and attitude rate geometric controller for a drone, enabling stable flight at speeds up to 7 m/s in both SITL and hardware
- **Gimbal Control**: Designed and tested a look-at feature for gimbal control, enabling the drone to orient the camera toward specific lat-long coordinates at speeds up to 10 m/s
- **Time Synchronization**: Adapted a driver to timestamp the on-board computer(Jetson based) with GPS time using Chrony, enabling time synchronization with Pixhawk via shared memory

Google Summer of Code – Open Robotics | Student Developer *(May '23 - Aug '23)*

- Improved **ROS2** & Gazebo maritime simulation (VRX) performance via code refactoring & wave model integration

RESEARCH EXPERIENCE

TRACE Paw: Terrain Recognition And Contact force Estimation Paw *(May '22 - May '23)*
Guide: Prof. Dr. Kostas Alexis, Autonomous Robots Lab (ARL) *NTNU, Trondheim, Norway*

- Designed and **prototyped an open-source**(), sensorized paw for legged robots, integrating Arduino Nicla Vision for real-time vision-based 3D force estimation (up to 150N) and audio-driven terrain classification
- Developed and deployed FCNN-based **TFLite** models and classical algorithms (PCA, blob detection & **optical flow**) on edge devices using **Micropython** and OpenMV for force analysis
- Implemented sensor fusion (LSM6DSOX IMU) for orientation tracking and tested flexible materials (TPU, EPU, Silicone) to optimize the compliant pad for accurate terrain interaction

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 2nd** 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 6th** 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 **1st 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

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)*
Guides: 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

Adaptive Control of Autonomous Vehicle | *SC617: Adaptive Control Theory* *(Nov '21)*

- 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 | *SC627: Motion Planning of Autonomous Vehicles* *(Apr '23)*

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

Optimization of Drone Delivery Routes | *AE755: Optimization for Engineering Design* *(Apr '23)*

- Implemented Simulated Annealing from scratch for TSP with energy, capacity & pickup/delivery constraints

Instance Segmentation - Self Driving Cars | *Seasons of Code, WnCC, IIT Bombay* *(Jul'21)*

- Performed transfer learning on Mask RCNN for vehicle detection and integrated it with CARLA simulator

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

Technical	• Developed an assistive document reader, dictator & wikipedia search platform for visually impaired • Built touchless elevator control system with RPi and 8X8 LED Matrix using local HTTP server
Cultural	• Volunteered in Kaladarshan (annual photography and fine arts exhibition) for road painting • Awarded distinction in Kathak by Akhil Bharatiya Gandharva Mahavidyalaya Mandal, Mumbai
Mentorship	• Delivered a session on Serial Communication Protocols in embedded systems to 200+ students, using TinkerCAD simulations and practice assignments • Guided 9 freshmen for a project based on Robotics and Image Processing for Summer