

Ridhi Puppala

📍 IIT Madras, Chennai 600036, India 🌐 [ridhipuppala.github.io](https://github.com/ridhipuppala)

EDUCATION

Indian Institute of Technology Madras (IIT Madras) 2020 (ongoing)
B.Tech. in Mechanical Engineering and M.Tech. in Robotics (Minor - Control Systems)
CGPA: 8.3/10 | Advanced GPA (from 6th semester): 8.75/10

Sri Chaitanya Junior College, Raman Bhavan, Vijayawada 2015
Class XII (Board of Intermediate Education Andhra Pradesh) | 97.7%

Dr. KKR's Gowtham International School, Vijayawada 2013
Class X (Central Board of Secondary Education) | 10/10

PUBLICATIONS

- **Puppala, R.**, Sivadasan, N., Vyas, A., Molawade, A., Ranganathan, T. and Thondiyath, A. (2019). "*Design, Estimation of Model Parameters, and Dynamical Study of a Hybrid Aerial-underwater Robot: Acutus*". In Proceedings of the 16th International Conference on Informatics in Control, Automation and Robotics (ICINCO) [[SCITEPRESS](#)]
- Abhijeet Vyas, Akshay Molawade, Nikhil Sivadasan, **Ridhi Puppala**, Thiagarajan Ranganathan and Asokan Thondiyath. "*Modelling and Dynamic Analysis of a Novel Hybrid Aerial-Underwater Robot - Acutus*". In Proceedings of OCEANS 2019 MTS/IEEE Marseilles, France [[IEEE](#)]

PROFESSIONAL AND RESEARCH EXPERIENCE

Distributed coordination and control of aerial/ground multi-robot systems ongoing
Dynamics & Control Lab, IIT Madras Master's Thesis

- Designing a **distributed multi-robot framework** incorporating **collision avoidance (CA)** and **connectivity maintenance** under limitations of motion, sensing and communication applicable to **ground robots** or **UAVs**
 - Conducted literature study on wide range of topics like distributed coordination control, coverage planning, dynamic consensus, formation control, rendezvous and constraint based safety and resilience for multi-robot systems
 - Developed MATLAB-ODE and ROS-Gazebo multi-robot simulation packages for validation of algorithms
 - Proposed a method to construct a proximity network graph for random spatial distribution of robots that is reduced to a minimum spanning tree (MST) using Prim's or Kruskal's algorithm (implemented in MATLAB & rospy scripts)
 - Proposed and validated a novel **network based rendezvous algorithm** that ensures connectivity maintenance
 - Formulating a **LiDAR enabled multi-robot CA algorithm** by exploiting theoretical concepts from set theory, barrier functions & convex optimization which will be tested through MATLAB & ROS-Gazebo simulations
- Concepts/Skills:** Multi-robot motion planning, CA, Distributed Control, Graph theory, MATLAB, ROS-Gazebo

Reactive planning for global navigation using minimal sensing and computation May'19-July'19
The Autonomous Robots and Multi-robot Systems Lab, IIT Bombay Intern

- Formulated **global online navigation framework** that just utilizes coarse **bearing** and **2D LiDAR** measurements
 - Designed a novel sensor based trigger to switch between homing (source-seeking) & collision avoidance modes
 - Derived controller for following dynamic target agents/robots using **geometry, robot kinematics, nonlinear control**; theoretically proved **stability & robustness** for overall switched system while ensuring practical feasibility
 - Developed a scalable & modular multi-robot simulation package on ROS-Gazebo platform
 - Successfully validated controller using ROS-Gazebo simulations and experiments in VICON motion capture setup
 - Manuscript containing our research is under preparation for submission to top conferences
- Concepts/Skills:** Kinodynamic Planning, LiDAR based CA, Nonlinear Control, ROS-Gazebo, Real-time testing

Design optimization and its performance investigations of underwater glider-RoBuoy Aug'18-May'19
Robotics Lab, IIT Madras Research Assistant

- Modelled **nonlinear dynamics** of underactuated shape-changing glider based on **Newton-Euler formulation**
 - Optimized gliding-depth-to-range ratio w.r.to fixed wing location & area through multi-objective optimization
 - Proposed mode switching control algorithm using pitch feedback to achieve smooth & energy-efficient trajectories and correlated experimental trajectory data with dynamical simulation results
- Concepts/Skills:** Design Optimization, System Modelling, Embedded programming, Simulink, Hardware Testing

Modelling of hybrid aerial-underwater robot-*Acutus*

Robotics Lab, IIT Madras

Jan'18–Dec'18

Research Assistant

- Developed aerial-underwater vehicle that switches between quadcopter & fish morphology with **minimal actuation**
 - Estimated inertial, added mass & damping parameters using computational system identification techniques and observed **hydrodynamic drag reduction** by about 50% compared to existing hybrid systems
 - Constructed mathematical model for **dynamical analysis**; developed prototype to practically validate concept
 - Implemented and experimentally tested the cascaded PI-PID controller for navigation of **aerial multi-rotor system**
 - Co-authored two conferences publications and presented at the proceedings of **ICINCO 2019** in Prague, Czechia
- Concepts/Skills:** System Modelling, System Identification, Simulink, Hardware & Real-time Testing

Design & development of in-house Junker test setup and Load washer

Bajaj Auto Ltd. (Pune R&D)

May'18–Jul'18

Intern

- Designed custom Junker test rig incorporating flexibility in operating frequency, load or test specimen type
 - Improved maximum operating frequency by four fold and performed failure analysis on the digital twin
 - Developed mathematical model for custom load washer & validated model with experimental strain vs load data
- Concepts/Skills:** Design for Manufacturing, CAD, Multi body simulation (MBS), Finite Element Analysis (FEA)

TECHNICAL EXPERIENCE

Semi-autonomous Mars rover for University Rover Challenge (URC), Utah USA

[Team Anveshak](#) | Centre for Innovation (CFI)

Sept'16–Dec'18

Head & Senior Member

- Headed **20+ member team** to secure **25th** rank (amongst 95 international teams) in URC'18 at Utah, USA
 - Developed **ROS packages** for joystick control and **autonomous GPS waypoint navigation** of six wheeled rover
 - Devised IK control for 3-DOF robot arm; chassis drive & steering control for different wheel configurations
 - Interfaced onboard electronics, BMS, sensors & microcontrollers with rover computer using custom designed PCBs
 - Implemented Deep Neural Networks for waypoint marker detection along with IMU+GPS+LiDAR based navigation
 - Modified ROS Navigation Stack specifically for our rover with customized goal navigation and local CA controllers
 - Streamlined logistics, finance, management functions and led the efforts for corporate sponsorship & crowdfunding
- Concepts/Skills:** Sensor Fusion, Localization, Mapping, Planning, Computer Vision, Machine Learning, Hardware

PROJECTS

Stereo vision based position tracking of smartphone Virtual Reality (VR) headset

Course: Virtual Reality Engineering | Guide: Prof. M. Manivannan

Jul'18–Nov'18

- Proposed standalone & cost-effective method of position tracking for Smartphone VR systems since they only possess accurate head orientation tracking systems and lack motion tracking mechanisms
 - Modified & implemented CMU's **openpose** CNN framework for vision-based real-time full human body tracking
 - Incorporated disparity calculations on **CNN** based human body tracking from two USB cameras for 3D shoulder pose estimation, which is then used to compute **3D real-time position** of smartphone VR headset
- Concepts/Skills:** Depth estimation, Stereo Vision, Deep Neural Networks, Hardware Testing, TensorFlow, Unity3D

Collaborative framework for aerial and ground robots for visual terrain exploration

Semester project - RAFT Lab | Guide: Prof. Ranjith Mohan

Jul'18–Dec'18

- Implemented sequential sensor method based Asynchronous Kalman filter from literature for **ground robot localization**; local position & quaternion attitude estimator of the PX4 firmware for **aerial robot localization**
 - Implemented dense & sparse point cloud generation from ZED API for elevation mapping & traversability estimation
 - Scripted codes for Cost map generator, Dijkstra's algorithm, Pure pursuit controller for cooperative navigation
- Concepts/Skills:** UAV Localization, Navigation & Controls, Visual Odometry, SLAM, Path Planning, ROS

Neural networks (NN) based fastener sorting for industries

Course: AI in Manufacturing | Guide: Prof. Samuel G.L.

Jan'18–May'18

- Achieved **91%** testing accuracy by training feed forward **NN classifier** on custom fastener data set generated from image augmentation of smartphone pictures of five classes of bolts, nuts and bearings
 - Proposed dimensional measurement and **feature extraction** of classified part in constrained environment settings with direct applications to automobile manufacturing and recycling lines using classical image processing algorithms
- Concepts/Skills:** Machine Learning, Object-oriented programming, Image augmentation, OpenCV, TensorFlow

Model predictive controller (MPC) for non-linear FCC model

Jul'17–Nov'17

Course: Modern Control Theory | Guide: Prof. Raghunath Rengasamy

- Implemented EKF based **state estimation** on discretized non-linear model using MATLAB ODE Suite
 - Programmed **MPC** and analyzed effects of changes in initial value, control & prediction horizon, EKF parameters
- Concepts/Skills:** Discrete State space models, EKF state estimation, Model Predictive Control design, MATLAB

Self orienting arm controlled with two BLDC propulsion units

Jan'17–May'17

Course: Measurement, Instrumentation and Control | Guide: Prof. Sathyan Subbiah

- Developed prototype of centrally pivoted arm whose orientation is controlled with BLDC propulsion units
 - Designed and tuned a **PID** controller for **active orientation control** against disturbances & static loads
- Concepts/Skills:** Classical control methods, Linear systems theory, PID control - Design & Tuning, Hardware

Portable and cost-effective 3D Scanner for hobbyists

Feb'16–Aug'16

Student led project | Electronics Club, CFI, IIT Madras

- Developed a **cost-effective & portable** 3D scanner with limited accuracy using **computer vision algorithms**
 - Conceptualized frugal scanning setup with elements like USB camera, laser & motorized rotating platform
 - Scripted algorithm to extract laser pixels & stitch them to obtain scanned object's **3D point cloud**
- Concepts/Skills:** Computer Vision, Morphological transformations & Denoising algorithms, OpenCV, Hardware

COURSEWORK AND TECHNICAL SKILLS

Introduction to Field & Service Robotics	Introduction to Robotics	Robotics Lab
Mechanics & Control of Serial Robots	Modern Control Theory	Linear Algebra
Guidance & Control of Marine Vehicles	Nonlinear Control	Differential Equations
Advanced Linear Control System	Instrumentation & Control	Probability & Statistics
Optimization methods in Mech. design	Automation & AI in Mfg.	VR Engineering
Software	: Robot Operating System (ROS), Gazebo, MATLAB, Simulink, OpenCV, PX4	
Hardware	: GPS, IMU, LiDAR, Camera, Arduino, STM, RPi, TX2, Odroid, Linux based SBCs	
Programming	: C, C++, Python, Data Structures & Algorithms (Windows & Linux)	
CAD/CAE	: Fusion 360, SolidWorks, AutoCAD, ANSYS, ADAMS MSC, Eagle (PCB)	
Prototyping	: 3D printing, CNC, Laser cutting, Milling, Lathe, Water Jet, Soldering	
Other Skills	: L ^A T _E X, Git, LabVIEW, Android Studio, Unity3D, Microsoft Office	

EXTRACURRICULAR AND SOCIAL ACTIVITIES**Robotics Workshop Coordinator | Shaastra'16 (Tech Fest of IIT Madras)**

2016

- Conducted certified workshops, **teaching** robotics to **350+** students from colleges across India
- Formulated problem statement for Vision based Object tracking workshop with custom robotic kits
- Administered the availability of the workshop as a free short online course on EdXengine

Publicity & Outreach Coordinator | Saarang (Cultural fest of IIT Madras)

2016

- Boosted online engagement by **50%** & Saarang **footfall** by **10%** through India wide publicity events
- Developed **50+** Saarang student ambassador network from amongst various colleges in Hyderabad
- Organized Light Music event at zero expense through **sponsorship deals** with colleges & media studios

Volunteer | Lead India Movement

2010

- Volunteered for Lead India 2020 mission started by Dr. A.P.J. Abdul Kalam to inspire young India
- Taught Math & Science subjects and donated books & stationery to underprivileged schools students
- Conducted workshops and delivered lectures to school students on mental and social awareness