

# Sumanth V Udupa

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## EDUCATION

### PES UNIVERSITY

*BTech in Electrical and Electronics* (GPA: 8.46/10)

Bangalore, India  
Aug 2017 - Aug 2021

- Awarded **CNR Rao Merit Scholarship** in 3rd semester (Top 20% in the department).
- Earned **Distinction Award** in 3rd, 4th, 5th, 6th, 7th and 8th semester.

## SKILLS

- **Technical:** Pytorch, TensorFlow, OpenCV, ROS, Gazebo.
- **Programming:** Python, C++, C/Embedded C, MATLAB, Simulink, LaTeX.
- **Hardware:** Nvidia Jetson devices, Raspberry pi, Arduino, AVR, MSP430, ARM.

## PUBLICATIONS

- Aniruddh Sikdar, **Sumanth Udupa**, Prajwal Gurunath, Suresh Sundaram. "**DeepMAO: Deep Multi-Scale Aware Overcomplete Network for Building Segmentation in Satellite Imagery**." In *Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR) Workshops*, 2023, pp. 487-496.
- Aniruddh Sikdar, **Sumanth Udupa**, and Suresh Sundaram. "**Fully complex-valued deep learning model for visual perception**." In *ICASSP 2023-2023 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*, pp. 1-5.
- Aniruddh Sikdar, **Sumanth Udupa**, Suresh Sundaram, and Narasimhan Sundararajan. "**Fully Complex-valued Fully Convolutional Multi-feature Fusion Network (FC2MFN) for Building Segmentation of InSAR images**." In *2022 IEEE Symposium Series on Computational Intelligence (SSCI)*, pp. 581-587.
- **Sumanth Udupa**, Ayush Das, and Ajay Victor. "**Graph Inspired Geometric Area Allocation for Swarm of Robots in a Warehouse Environment**." In *2022 8th International Conference on Control, Automation and Robotics (ICCAR)*, pp. 101-104.

## RESEARCH EXPERIENCE

### Artificial Intelligence and Robotics Lab, IISc Research Assistant

Bangalore, India  
Aug 2021 - Present

#### Deep Multi-scale Aware Overcomplete Network for Building Segmentation in Satellite Imagery

Nov 2022-Mar 2023

- Spearheaded a project focused on addressing the challenge of detecting and segmenting small and complex-shaped buildings in densely cluttered environments using electro-optical (EO) and synthetic aperture radar (SAR) satellite imagery.
- Proposed a novel architecture Deep Multi-scale Aware Overcomplete Network (DeepMAO) that comprises of an overcomplete branch that focuses on fine structural features and an undercomplete branch that is tasked to focus on coarse, semantic-rich features.
- Introduced a novel self-regulating augmentation strategy, *LossMix*, aimed at enhancing the representation of misclassified pixels within the imagery.
- Achieved state-of-the-art building segmentation performance in both EO and SAR image modalities through the implementation of the proposed approach.

#### Fully Complex-Valued Deep Learning Model for Visual Perception

Apr 2022-Nov 2022

- Developed a novel fully complex-valued learning scheme to train a fully complex-valued CNN using a newly proposed complex-valued loss function which perform well on both real and complex-valued datasets.
- Initiated research driven by the recognition of the extensive representation capabilities offered by deep learning models operating entirely in the complex domain.

#### Multi-Modal Domain Fusion for Multi-Modal Aerial View Object Classification

Jan 2022-Mar 2022

- Designed a novel Multi-Modal Domain Fusion network and a training strategy to learn the domain-invariant features from multi-modal data (electro-optical image data and synthetic aperture radar image data) and use it to classify the aerial view objects.
- Work conducted as a part of the 18th IEEE Workshop on Perception Beyond the Visible Spectrum (CVPR workshop) 2022 challenge.
- Achieved *Top-5 leader-board result* in the data-fusion track and *Top-10 leader-board result* in the missing-modality track.
- Proposed solution was deemed innovative and was featured in the organizers' *CVPR workshop paper*.

#### Complex-Valued Neural Networks for Building Segmentation of InSAR images

Aug 2021-Jan 2022

- Formulated a novel fully complex valued learning scheme for a novel Fully Complex-valued Fully Convolutional Multi-feature Fusion network to operate and learn in the complex domain using orthogonal decision boundary theory.
- Introduced a novel complex valued pooling layer within the proposed architecture, which uses both the magnitude and the *phase information* of the complex-valued tensor, ultimately leading to the state-of-the-art results.

### Deep Learning Based Localization and Control of Indoor Robots

- Designed an autonomous robot that localized itself using deep learning in an indoor environment.
- Conducted a simulation-based project utilizing the Gazebo simulator, where a custom RGB image dataset was generated by controlling the robot's movements within the simulation environment using teleop commands.
- Produced ground truth data for the dataset through the fusion of wheel encoder and inertial measurement unit(IMU) data using a Kalman filter.
- Utilized a Resnet-50 backbone as the core convolutional neural network(CNN) model for feature extraction, followed by passing the feature vector through a long short-term memory(LSTM) network to capture global context and determine the robot's pose.
- Implemented a pure pursuit controller to facilitate the robot's navigation within the simulated indoor environment.

### Estimation and Control of robots in an abstract space

- Designed and implemented a multi-robot formation system utilizing swarm-based principles, tailored for indoor applications.
- Focused on enabling precise tracking of robot positions relative to each other. Leveraged data from IMUs and geared motor encoders to estimate robot positions using dead reckoning.
- Utilized relative positioning techniques to calculate the distance traveled by each robot from their initial positions. Established communication between the leader and follower robots through the ROS framework.

## PROJECTS

### **Graph Inspired Geometric Area Allocation for Swarm of Robots in a Warehouse Environment** Jun 2021- Oct-2021

- Designed a *graph based geometric area allocation framework* that streamlined the process of task allocation efficiently and also reduced the infrastructure costs in a traditional industrial setting.
- Implemented and tested the framework for a pick and place task specification for a swarm of robots.
- Introduced a fail-safe algorithm that detects robot failures and dynamically re-adjusts the area allocations to ensure that the overall process continues unhampered.

### **Robotic Process Automation using Swarm Behaviour**

Jan 2021-Jul-2021

- Led the project's perception module, coordinating multiple robots for precise localization and navigation using ROS Navigation Stack, orchestrating seamless pick-and-place operations, and implementing accurate environmental mapping with Google Cartographer.
- Sorting of packages was done based on shape and color of the object using OpenCV. Communication between the robots was done using ROS.
- The hardware used in this project included the Jetson Nano and Zed camera.

### **Autonomous Quadcopter for the International Aerial Robotics Competition '19 and '20**

Aug 2018-Jun-2020

- Worked on the autonomous navigation and simultaneous localization and mapping(SLAM) of the quadcopter using *Hector ROS package* on Gazebo.
- Involved in the development of the PID controller code for the drone to navigate from one point to other autonomously.

### **QR Scanning Quadcopter**

Dec 2019-Jan 2020

- Worked on transmission of video feed from raspberry pi to another processor via TCP/IP using socket library in Python for *IIT Bombay Drone Challenge*.
- Responsible for the code integration of the QR code detection and the video feed transmission.

### **Maze Solving Robot**

Oct 2019-Jan 2020

- Employed Python and OpenCV to train a machine learning model using keras and MNIST dataset to detect numbers in the maze while solving it using Dijkstra's algorithm.
- Worked on ATMEGA 2560, ESP32 micro-controllers and proximity sensors to functionalize the robot.

### **Soccer Playing Robot**

Jan 2018-Mar 2018

- Implemented algorithms for color detection using OpenCV image processing features like masking, thresholding and some filtering operations like erosion, dilation to remove the noise.
- Responsible for the interfacing of DC Motors, motor drivers and raspberry pi.

## LEADERSHIP AND HONORS

- Core member leading the **Vision/Perception, Simulation and Navigation** domain in '*Team Aeolus*', the official Aerial Robotics and Aero Modelling Club of PES University from Aug 2018-Jun 2020.
- Core member of **IEEE RAS** student chapter of PES University from Aug 2018-Jun 2020.