Sumanth V Udupa

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EDUCATION

PES UNIVERSITY Bangalore, India
BTech in Electrical and Electronics (GPA: 8.46/10) 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.**

PUBLICATIONS

- **Sumanth Udupa**, Prajwal Gurunath, Aniruddh Sikdar, Suresh Sundaram. "**MRFP: Learning Generalizable Semantic Segmentation from Sim-2-Real with Multi-Resolution Feature Perturbation**." Under Review.
- 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.
- **Sumanth Udupa**, Aniruddh Sikdar, and Suresh Sundaram. "**Multi-Modal Domain Fusion for Multi-modal Aerial View Object Classification**." arXiv preprint arXiv:2212.07039 (2022).
- 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, Indian Institute of Science Bangalore, India
Research Assistant Aug 2021 - Present

Learning Generalizable Semantic Segmentation with Multi-Resolution Feature Perturbation Mar 2023-Present

- Led a project to enhance computer vision model generalization for semantic segmentation in the Sim-2-Real setting, particularly for the autonomous driving scenarios.
- To alleviate the large distribution shift between simulated data and real world data, a novel Multi-Resolution Feature Perturbation(MRFP) technique was proposed to randomize high granularity features that is source domain specific and modify the style of the coarse features.
- Proposed technique is a simple, computationally efficient and transferable module which helps state-of-the-art DNNs to learn robust domain invariant features for the task of semantic segmentation.
- Currently working towards tackling the problem of *continual domain shift* in real-world applications, where existing domain generalization works are ineffective.

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 data and synthetic aperture radar data) and used it to classify the aerially viewed objects.
- Attained *Top-5 leader-board result* in the data-fusion track and *Top-10 leader-board result* in the missing-modality track at the 18th IEEE Workshop on Perception Beyond the Visible Spectrum(CVPR workshop) 2022 challenge.
- 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.

Robotics Innovations Lab, Indian Institute of Science — Bangalore, India
Project Intern — Jun 2020 - Dec 2020

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.
- Employed Resnet-50 as the core CNN model for feature extraction, followed by LSTM for capturing global context and determining the robot's pose.
- Implemented a pure pursuit controller to facilitate the robot's navigation within the simulated indoor environment.

Centre of Excellence, PES University — Bangalore, India
Project Intern — Jun 2019 - Sep 2019

Estimation and Control of robots in an abstract space

- Designed and implemented a multi-robot formation system 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.

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 develpoment 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.

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.