Sumanth V Udupa

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PERSONAL DETAILS

I am Sumanth V Udupa (full name in passport: Sumanth Vigneshwara Udupa), an Indian national residing in Bengaluru, Karnataka. You can contact me via phone at +91-7022815941 and email at sumanthudupa.su@gmail.com. Fluent in English, with proficiency in Kannada and intermediate skills in Hindi, I am well-equipped for diverse communication needs.
I have 2.5+ years of research experience in the field of machine learning and computer vision as a Research Assistant at the Indian Institute of Science (IISc), Bengaluru. You can find my research output identifier here: Google Scholar.

EDUCATIONAL QUALIFICATIONS AND ACADEMIC AWARDS

PES UNIVERSITY Bengaluru, India
Bachelor of Technology in Electrical and Electronics Engineering (GPA: 8.46/10) Aug 2017 - May 2021

- Specialization in *Embedded Systems*.
- Awarded a **40% tuition fee waiver through the CNR Rao Merit Scholarship in 3rd semester** (**Top 20%** in the department).
- Earned **Distinction Award in 3rd, 4th, 5th and 6th semester.**
- Capstone Project: "*Robotic Process Automation for Industrial Warehouses using Swarm Behavior*" with the technical report of word length approximately 15000 words.

RESEARCH OUTPUTS/PUBLICATIONS

- **Sumanth Udupa**, Prajwal Gurunath, Aniruddh Sikdar, Suresh Sundaram. "**MRFP: Learning Generalizable Semantic Segmentation from Sim-2-Real with Multi-Resolution Feature Perturbation**:" Accepted for publication in the *IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR) 2024*. Acceptance rate $\approx 25\%$
  h5-index* of the conference: 422
  - Led the project, from problem formulation, ideation, and implementation to paper writing. The focus was on enhancing computer vision model generalization for semantic segmentation in the Sim-2-Real setting, with a particular emphasis on autonomous driving scenarios.
- 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. Acceptance rate $\approx 50\%$
  h5-index* of CVPR workshops: 108
  - Spearheaded the ideation and implementation aspects of the project that aimed at tackling 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 while also significantly contributing to writing the methodology and experiments sections of the paper.
- 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. (**Oral presentation**) *Oral acceptance rate* $\approx 24\%$
  h5-index* of the conference: 123
  - Was instrumental in the postulation and the implementation phase of the research, while also contributing significantly in drafting the methodology and experimental sections of the paper as a co-first author.
- **Sumanth Udupa**, Aniruddh Sikdar, and Suresh Sundaram. "**Multi-Modal Domain Fusion for Multi-modal Aerial View Object Classification**." arXiv preprint arXiv:2212.07039 (2022).
  - Was primarily involved in the design and implementation of the methodology proposed in the above research. Also played a key role in drafting the paper.
- 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. (**Oral presentation**)
  - Played a pivotal role in the formulation and implementation of the research while contributing significantly in drafting all sections of the paper, from introduction to experimental analysis, as a co-first author.
- **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.
  - Led the research direction by defining the problem statement, executing the idea, and composing all sections of the paper.

* denotes that the h5-index metric used for measuring the conference standing has been taken from *Google scholar metrics*.

EMPLOYMENT HISTORY/RESEARCH EXPERIENCE

Artificial Intelligence and Robotics Lab, Indian Institute of Science — Bengaluru, India
Research Assistant — Aug 2021 - Present

Zero-shot online continual adaptation — Nov 2023-Present

- Currently focused on addressing the challenge of continual domain shift in practical applications, where conventional vision models often struggle to maintain performance.
- Exploring the use of foundation models/VLMs to improve the zero-shot online continual adaptation.
- Specifically researching on online domain adaptation on sensor/modality shifts for aerial slant angle robotic perception.

MRFP: Learning Generalizable Semantic Segmentation with Multi-Resolution Feature Perturbation — Mar 2023-Nov 2023

- The project aimed to improve the generalization of computer vision models for semantic segmentation in the Sim-2-Real setting, focusing on 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.

Deep Multi-scale Aware Overcomplete Network for Building Segmentation in Satellite Imagery — Nov 2022-Mar 2023

- The project aimed at tackling 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.
- Played a pivotal role in initiating the 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

- Proposed 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 in the semantic segmentation task.

Robotics Innovations Lab, Indian Institute of Science — Bengaluru, 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 Bengaluru, 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.

OTHER RESEARCH EXPERIENCE/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.
- This project was built upon my undergraduate thesis project which lead to a publication.

Robotic Process Automation using Swarm Behaviour Jan 2021-Jun-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.
- Research conducted as a part of capstone project (senior year thesis project) which consisted of a technical report of word length of approx. 15000 words.

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.

ACADEMIC REFEREES

- Referee 1
  - Prof. Suresh Sundaram
  - Professor at the Department of Aerospace Engineering, Indian Institute of Science, Bengaluru, Karnataka, India.
  - Can be contacted via phone at +916363962171 and email at vssuresh@iisc.ac.in. Office Address: Department of Aerospace Engineering, CV Raman Road, Indian Institute of Science, Bengaluru, Karnataka 560012.
  - My research supervisor for over 2.5 years of my employment at the Indian Intitute of Science. He is my supervisor for most of the research outputs stated above.
- Referee 2
  - Dr. Venugopal N
  - Professor at the Department of Electrical and Electronics Engineering, PES University, Bengaluru, Karnataka, India.
  - Can be contacted via phone at +919900017826 and email at venugopaln@pes.edu. Office Address: Department of Electrical and Electronics Engineering, PES University-RR campus, 100 Feet Ring Road, Banashankari Stage III, Dwaraka Nagar, Banashankari, Bengaluru, Karnataka 560085.
  - My academic advisor, research examiner and lecturer at PES University during my undergraduate studies. I've known and worked under his guidance for over 2 years.

PROFESSIONAL AFFILIATIONS AND MEMBERSHIPS

None to date

RESEARCH GRANTS AND RELEVANT AWARDS

None to date