Ajay Narasimha Mopidevi

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Publications

- "RMap: Millimiter-Wave Radar Mapping through Volumetric Upsampling" ***(IROS 2024)***
- "Tell Me Where to Go: A Composable Framework for Context-Aware Embodied Robot Navigation" ***(CoRL 2023)***
- "Grouped BERT for Multi-Label classification to reason the human values behind the arguments" ***(SemEval-2023)***

Experience

Vignesh Kasinath Lab, University of Colorado Boulder Boulder, CO
Research Assistant *Apr 2023 - Present*

- Designed end-to-end pipeline for semantic segmentation of low resolution and sparse cellular structures from cyro electron tomography images using **Multi-UNet** architecture, resulting in a significant **13%** boost in F1-score
- Developed a 2-stage semi-supervised segmentation framework to segment cellular regions and fine-grained cellular structures, reducing the number of manual annotations by **85%**
- Developed unsupervised algorithms to effectively segment different instances of chromosomes in a nucleus
- Designed advanced image processing pipelines for precise 3D pose extraction of cellualr structures from volumetric microscopic imaging data, leveraging connected components, spline interpolation, and geometric transformations
- Integrated fine-tuned Segment Anything Model (SAM) in the pipeline, eliminating manual parameter tuning and enhancing the performance of the segmentation masks by 20%

Autonomous Robotics and Perception Group, University of Colorado Boulder Boulder, CO
Research Assistant *Sep 2022 – May 2024*

- Developed RMap, a volumetric mapping framework that transforms sparse radar pointclouds to high resolution 3D lidar-like maps, achieving a significant improvement in F1-score **0.59** compared to 0.19 of traditional radar maps
- Designed UpPoinTr transformer for enhancing volumetric maps, surpassing the prior models by **8%** in F1-score
- Developed the pose-based region sampling algorithm to efficiently represent the 3D maps as minimal partial pointclouds, without any loss in details
- Developed custom CUDA pointcloud loss metrics to evaluate deviations from groundtruth in all three dimensions
- Enhanced the odometry estimation by **8%** using only the mmWave radar, by extracting the features from 3D radar images using transformer encoder to predict a 6DoF pose

Samsung Bangalore, India
Computer Vision Engineer *July 2020 - July 2022*

- Developed real-time **3D scene reconstruction** algorithm, only using depth from ToF sensors, optimized to **20fps**
- Improved the accuracy by **5%** of the reconstructed scene by removing outliers using gaussian smoothing
- Automated pose alignment of reconstructed 3D scene with groundtruth, eliminating manual alignment in MeshLab
- Reduced the latency of Remosaic deep learning models for 200M pixel camera sensor using **quantization** and **pruning** techniques by 10% with an unnoticeable degradation of 0.1% in perceptual quality
- Optimized Samsung's CMOS camera sensor noise reduction algorithm with OpenMP parallel programming, thereby reducing the algorithm runtime by **33%**

Qualcomm Bangalore, India
Software Engineer *Aug 2017 - Jun 2020*

- Spearheaded the development and maintenance of python audio library to evaluate both the objective and perceptual audio quality of Bluetooth headsets
- Enhanced python automated test framework with new features that populate test vectors and visualize audio output signals, leading to a **10%-15%** reduction in both the validation and developments efforts

Eagle Eye Networks Bangalore, India
Research Intern *May 2017 - July 2017*

- Predicted the pedestrian/car trajectory in a video by estimating the optical flow for the YOLO precited objects
- Achieved 72% accuracy in segmenting location and trajectory anomalies through Incremental Spherical Clustering

Technical Skills

Languages: Python, C/C++, JavaScript, SQL, Matlab
Machine Learning Frameworks: PyTorch, Keras, Tensorflow, ONNX
Libraries: OpenCV, ROS, Open3D, NumPy, Matplotlib, pandas, scikit-learn, CUDA, OpenCL, MMDetection
Developer Tools: Git, Docker, Google Cloud Platform, AWS, Perforce, Visual Studio, PyCharm, IntelliJ, MeshLab

Education

University of Colorado Boulder — Boulder, CO
Masters of Science in Computer Science — GPA: 4.0/4.0 — *Aug. 2022 – May 2024*

Indian Institute of Technology Guwahati (IITG) — Guwahati, India
Bachelors of Technology in Electronics and Communication Engineering — *Aug. 2013 – May 2017*

Projects

LLM Guided Robot Navigation | *Python, ROS, C++, LLM*

- Developed NavCon, a low bandwidth framework for human-instructed robot navigation leveraging the vast contextual insights from Large Language Models(LLMs)
- Simulated NavCon framework to test the contextual understanding of the human instructions and generate programmable sections of object detection with success rate of 90%
- Evaluated NavCon in diverse real-world environments to guide Spot robot through complex human commands, achieving a success rate of **59%**, outperforming current visual grounding methods by **25%**
- Extracted 3D object locations referred from the instruction by projecting YOLO 2D object detections into 3D Map using weighted median filtering

Differential DEtection TRansformer | *Python, PyTorch, ONNX, ROS*

- Developed Differential Object Detection Transformer (DiffDETR) combining the differential transformer block in the DETR, to provide longer contextual understanding
- Integrated Rotary positional embeddings(RoPE), SwiGLU activation in the pytorch MultiheadAttention block to provide both absolute and relative positional embeddings
- Reduced the model parameters by 13%, while improving the mean Average Precision(mAP) on COCO 2017 dataset by 5%, comapred to DETR

Autonomous Car - 1/10 scale | *Python, ROS, C++ OpenCV*

- Engineered a 1/10 scale autonomous car with advanced obstacle detection and collision avoidance capabilities, integrating depth and range sensors for precise environmental perception
- Implemented real-time computer vision algorithms to process depth sensor data, accurately segmenting left, right, and front planes to determine the car's position relative to obstacles
- Developed Kalman filter to robustly estimate velocity of the car and distance to the closest frontal obstacle from the noisy range sensor measurements

Situation Aware Object Tracking | *C++, OpenCV*

- Enhanced Stochastic Mean Shift Algorithm, achieving an 8% performance improvement by enabling automatic adjustments for size, rotation, illumination, occlusion and rapid movements of the tracking object
- Detected illumination changes by transitions in Fourier DC coefficient in the video and used Color Edge Oriented features, which are invariant to illumination
- Identified occlusion changes using histogram of Oriented Optical Flow and utilized HOG features around SIFT keypoints to maintain robustness against partial occlusions

Influencer Recommendation System | *Python, Javascript, Docker, Kubernetes, Git, PostgreSQL, REST*

- Developed influencer recommendation application to identify relevant influencers for targeted product marketing
- Engineered a multimodal recommendation system with the textual and image queries, and rerank them with influencers' posts and engagement metrics to ensure optimal relevance
- Deployed the application on GCP, achieving robust scalability to accommodate multiple clients simultaneously

Awards & Recognition

- [2021] Received the **Spot** Appreciation award twice, given to top 5% performing employees at Samsung
- [2019] Rewarded **Qualstar** for continued excellence in improving the audio quality analysis framework