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Hardik Shah

Education

2019–Present **B.E. in Computer Science Engineering**, *BITS Pilani, Goa*, *9.58/10*.
w/ Minor in Data Science

- **Institute Rank 5** in a batch of 900 students
- Recipient of BITS Goa **Merit Scholarship** for 6 consecutive semesters awarded to **top 10** students across all departments– 100% tuition fee waiver.

Research Experience

Institution **Google Research, India** [Aug'22-Present]
Student Researcher, Machine Learning and Optimization Team
Undergraduate Thesis, Supervisor: ***Dr. Prateek Jain*** *(Sr. Staff Research Scientist, Google)*

Project Title Machine Learning Optimization for object detection on low-end smartphones.

Description Optimized on-device latency of large **character recognition models** used for OCR tasks in Google products like Lens, for **faster on-device inference** while maintaining accuracy. Improved parameter efficiency for OCR tasks by extending Singular Value Decomposition(SVD) techniques and Orthogonal Matching Pursuit(OMP) on 1x1 convolution kernels. Experimentally observed constant performance with 33% less parameters and 10% reduction in latency. Additionally reduced on-device latency of **MobileNet** architectures for QR-code detection with GooglePay team.

Institution **DAAD WISE: Karlsruhe University of Applied Sciences** [May'22-Aug'22]
Summer Research Intern, Robot Vision Lab
Supervisor: ***Prof. Niclas Zeller***

Project Title Camera based 3D Dense Reconstruction for Mobile Robots

Description Designed an end to end pipeline for multi-view stereo dense 3D reconstruction from a handheld stereo-camera(Intel RealSense) that outputs stable dense pointclouds. In particular, extracted and tracked keyframe poses and keypoints from BASALT-VIO. Encoded information from multiple camera views in a cost volume used for self-supervised training of a **U-Net** adapted architecture design-MonoRec. Benchmarking of trajectory estimation done on rectified TUM-VI dataset before deployment.

Research Projects

Title **Project Kratos, A Mars Rover** [Website] [Code] [2020 - 2022]
Autonomous Subsystem lead

Description Development of a mars rover as part of the University Rover Challenge(URC). Team lead of the Autonomous Subsystem, responsible for autonomous traversal. Program design, implementation and deployment of mapping, planning and control nodes on Jetson Xavier for obstacle avoidance and object tracking(arrows, ARTags).
Path planning and Perception-Implemented A*, RRT*, Dijkstra's on a 4 grid adjacency graph obtained from binary occupancy grid generated by ZED2i camera;
Tracking-Employed transfer learning on **YOLOv3**, **Mask R-CNN** algorithms for arrow detection. Achieved ROS integration using darknet_ROS(20 fps).
Control-Wrote a custom P-controller based **visual servoing** algorithm for following arrows and ARTags. [Demo Video]

Title **RGB Guided Sparse Depth Completion** [Jun'21-Present]
Prof. Sravan Danda, Prof. Aditya Challa, BITS Goa

Description Existing methods for depth completion and estimation tend to overfit with very less generalization across datasets. Focused on developing methods to identify statistical patterns in coupled RGB-depth maps. Combining empirical results from validating statistical hypotheses for incorporating domain knowledge with learning based estimation for sparse depth completion. Achieved comparable results against computationally heavy deep learning based methods on **KITTI dataset**.

Title **Deep Hashing Networks for downstream image classification tasks** [May '22]
Spring '22 | CS F425: Deep Learning Course Project

Description Proposed the use of a deep hashing network (CIMON) for image classification on the STL-10 dataset. Experimented with use of CIMON's rich hash codes as latent feature representations, traditionally used for efficient retrieval based tasks. Achieved comparable accuracy on the test set to existing methods in unsupervised setting.

Technical Strengths

Languages Python, C++, C, JAVA, C#, MATLAB, Latex, HTML, CSS

Softwares Pytorch, Tensorflow, Keras, JAX, Numpy, OpenCV, Unity, Gazebo, Verilog, Robot Operating System (ROS), AutoCAD, Android Studio

Relevant Coursework

CS Courses Data Structures and Algorithms, Object Oriented Programming, Logic in Computer Science, Operating Systems, Principles of Programming Languages, Computer Networks

EE Courses Digital Design, Microprocessors and Interfacing, Computer Architecture

Math Courses Linear Algebra, Statistical Inference and Applications, Discrete Mathematical Structures in Computer Science, Probability and Statistics, Calculus

ML Courses Statistical Methods, Foundations of Data Science, Machine Learning, Deep Learning

Leadership and Teaching

2021-2022 **Subsystem Lead, Autonomous Subsystem Project Kratos**, *BITS Goa*.
Managing a team of 14 members. Continuous designing and improvement of all the framework components through research. Managed manufacturing, fabrication and integration of the essential rover components for the subsystem. Involved in close collaborations with other teams.

Fall 2022 **Student Mentor: ASCII Mentorship Programme**, *BITS Goa*, [Github Org].
Mentoring a team of 15 second and third year students in a semester long project towards exploring core domains in Computer Science. [Project Repository]

Spring 2021 **Teaching Assistant: Discrete Structures in Computer Science**, *BITS Goa*.

Awards and Achievements

2022 University Rover Challenge, Utah: Project Kratos secured **1st** position in India

2022 Anatolian Rover Challenge, Turkey: Project Kratos secured **2nd** position globally

2022 Recipient of **DAAD WISE** research scholarship(Germany)

2022 Recipient of **MITACS Globalink** research scholarship(Canada)

2022 Recipient of the Singapore International Pre-Graduate Award (**SIPGA**)

Summer 2021 Selected for the **Microsoft Engage** Mentorship Program 2021

Extra Curricular Activities

- Part of college tennis team, representing institute at state and national tournaments.
- Completed the Goa River Half Marathon 2019 - 21km.
- Interests: Reading, Cycling, Swimming, Trekking, Chess