

Hardik Shah

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Education

2023–Present **MSc in Computer Science**, *ETH Zurich*.

2019–2023 **B.E. in Computer Science Engineering**, *BITS Pilani, Goa*, 9.64/10.

w/ **Minor in Data Science**

- **Institute Rank 6** in a batch of 900 students
- Recipient of BITS Goa **Merit Scholarship** for all 8 semesters awarded to **top 10** students across all departments– 100% tuition fee waiver.

Research Experience

Institution **Google Research** [Jan'23-Jun'23]
Student Researcher, Machine Learning and Optimization Team

Project Title End-to-End Neural Network Compression via $\frac{l_1}{l_2}$ latency surrogates [preprint*]

Description Developed a versatile **neural network compression** toolbox that optimizes for the model's FLOPs via a novel $\frac{l_1}{l_2}$ latency surrogate in various compression methods, including **pruning** and **low-rank factorization**. Extended the FLOPs regularizer to optimize over actual on-device latency using a latency look-up table of the target device. Achieved 11% reduction in latency on Pixel-6, and 15% reduction in FLOPs in compressing MobileNetV3 on ImageNet-1K without drop in accuracy, while still requiring $3\times$ less training compute than SOTA NAS techniques. For BERT compression on GLUE fine-tuning tasks, we achieve 50% reduction in FLOPs with only 1% drop in performance.

**Under review at ICLR '24*

Institution **Google Research** [Aug'22-Dec'22]
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 1×1 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 **Robot Vision Lab, Karlsruhe University of Applied Sciences** [May'22-Aug'22]
Summer Research Intern, DAAD WISE Scholarship
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.

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

Research Projects

- Title **Project Kratos, A Mars Rover** [[Website](#)] [[Code](#)] [[Demo Video](#)] [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-adjacency grid 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.
- 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. Redefined depth completion as interpolation problem on a grid graph with sparse-depth seed values. Using empirical results from hypotheses testing on LiDAR depth data for seed selection and context-aware **spatial seed propagation**. Achieved comparable results against computationally heavy deep learning based methods on **KITTI dataset**.
- Title **Deep Hashing Networks for downstream image classification** [[Code](#)] [May '22]
Prof. Tirtharaj Dash, BITS Goa
- 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.

Relevant Coursework

- ETH Zurich* Probabilistic Artificial Intelligence, Information Security, Computer Vision, Planning and Decision Making for Autonomous Robots, Vision Algorithms for Mobile Robotics
**in progress*
- BITS: CS Data Structures and Algorithms, Operating Systems, Computer Architecture, Database Systems, Compilers, Discrete Mathematical Structures in Computer Science
- BITS: ML Applied Statistical Methods, Foundations of Data Science, Machine Learning, Deep Learning, Artificial Intelligence

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)