PRANEET SINGH

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EDUCATION

Purdue University *Aug 2019 - Present*
PhD in Electrical and Computer Engineering

Ramaiah Institute of Technology *June 2013 - June 2017*
B.E in Electronics and Communication

TECHNICAL SKILLS

Programming:	Python, C++, MATLAB
Software & Tools:	PyTorch, Numpy, OpenCV, FFMPEG, HEVC, VVC, AWS, Github, Nginx, HuggingFace
Deep Learning:	CNNs, Transformers, Autoencoders, Deep Video Compression, Neural Fields, Vision Language Models, 3D Gaussian Splatting
Coursework:	Computer Vision, Deep Learning, Video Coding Systems, Convex Optimization Digital Image Processing, Computational Algorithms, Natural Language Processing
Management:	Lead Teaching Assistant for the Signals and Systems course at Purdue

RESEARCH PROJECTS

Compression of gaussian primitives to reduce the memory footprint of 3D/4D Gaussian Splatting
- Designed an end-to-end Neural network based compression algorithm for the attributes of 3D gaussians.
- Transformed Spherical Harmonics to grids and exploited inter-frame redundancies to improve 3DGS compression.

Joint Multi-modal Neural Field Representations for Audio and Video
- Mastered design principles of Neural Field architectures for images, video, and audio signals, encompassing Fourier embeddings, Sine/Swish activations, and Convolution-based structures (NeRV, NeRF).
- Designed innovative Neural Field architectures for joint audio-video representation using time-stamp coordinates.
- Concentrated on Model Pruning and Quantization methods, shifting focus from modality-specific compression.

Task Aware Image Quality Estimation for End-to-end Face Analytics
- Designed a novel task-specific Unsupervised Image Quality Estimators connecting image quality and face detection performance through the clever utilization of regularization layers like Dropblocks to measure image robustness.
- Developed new evaluation protocols for image quality estimators in face detection and recognition domains that reduced evaluation computational complexity.
- Investigated the use of Masked Vision Transformers for Image Quality Estimators for Face Recognition.

Task Aware Video Compression using Lightweight Edge-specific Neural Networks
- Assessed the impact of video compression on the performance of deep learning models used for computer vision tasks like pedestrian detection, face detection, and face recognition.
- Evaluated the impact of video compression on task performance for video codecs and encoder configurations.
- Developed a task-aware frame partitioning procedure for video encoders like HM and VVC, leveraging edge-based deep learning models to guide existing video encoders to intelligently allocate bits to regions computer vision tasks.
- Realized 6% bit-rate and 15% encoding time savings while maintaining video analytics under compression.

Guiding Image Quality Estimation using Vision Language Models
- Explored integrating vision-language and self-supervised learning for image quality assessment.
- Worked on the TADAC database with over 1.6 million images annotated for semantic content, distortion, and appearance, facilitating advanced research in vision-language modeling.

Lightweight Compression of Intermediate Neural Network Features (Video Coding for Machines)
- Investigated the capability of existing video codecs like HEVC to encode neural network intermediate features.
- Assessed the feasibility of splitting neural networks for effective encoding and transmission of intermediate features.
- Explored the application of Autoencoder models for Video Coding for Machines and Scalable Video Coding.

Dataset Curation and Systematic Evaluation of End-to-end Face Analytics
- Designed an end-to-end face analytics system for face detection and recognition inside an autonomous vehicle.

- Deployed a data collection system for recording faces across multiple camera modalities, camera angles, and lighting conditions in order to create a practical diverse dataset.
- Curated usable data from a large dataset for the systematic evaluation of the end-to-end face analytics system. Captured images were aligned using deep learning based homography techniques across multiple cameras.
- The curated data captures the interdependence between tasks such as face detection and recognition which is typically ignored in face datasets.

Background-Foreground Segmentation for Camera-Trap Images using RobustPCA
- Developed an unsupervised robust saliency predictor using robust PCA, which aids in differentiating between background and foreground in camera-trap images.
- This method eliminates the need for training, while offering performance similar to learning models such as R3-Net.
- System has been employed to and track animal movements, calculate population densities, and identify habitual patterns in animal activities.

EdgeDetect - A lightweight framework to detect DDoS attacks on Edge nodes
- Built a unique system to detect DDoS attacks on edge devices with the application of Recurrent Neural Networks.
- Accomplished state-of-the-art performance on the UNSW 2015 dataset with the advantage of maintaining minimal model architecture suitable for edge devices.

Traffic Analytics Architecture and Dataset for Indian Roads using a Monocular Surveillance Camera Network
- Designed and implemented solutions tackling traffic analytics such as vehicle count, detection of license-plates, speed computation, and estimation of queue-length.
- Constructed a real-time front-end Web Server System that delivers live RTMP and HLS video streams.
- Integrated features such as content sharing, discovering, routing, congestion managing, and load balancing.
- The full framework has been successfully installed and is operational in Electronic City, Bangalore, India.

WORK EXPERIENCE

Purdue University, WL *Aug 2019 - Present*
Graduate Research Assistant, ***Advisors: Dr. Amy Reibman, Dr. Edward J Delp***
- Task-aware Video Coding and Image Quality estimation. Understanding and mitigating the effects of compression on Computer Vision algorithms.

Dolby Laboratories Inc. *Sep 2024 - Dec 2024*
IP Legal-Video Coding Intern, ***Manager: Dr. Peng Yin***
- End-to-end neural network and conventional algorithms to reduce the memory footprint of 3D gaussian splats.

Dolby Laboratories Inc. *May 2023 - Aug 2023*
ATG Imaging & Machine Learning Intern, ***Manager: Dr. Guan-Ming Su***
- Machine learning approaches for multi-modal image/video and audio compression using Neural Fields representations. Filed a patent on the work done during the internship.

Apple Inc. *May 2022 - Aug 2022*
IMG Video Codec Standards Intern, ***Manager: Dr. Alexis Tourapis***
- Analysis of **Common Test Conditions** sequences in terms of spatial, temporal, noise and compressibility characteristics. Used novel ML techniques for Scalable Video Compression.

Indian Institute of Science *April 2018 - Aug 2019*
Research Assistant, ***Advisors: Dr. Abhay Sharma, Dr. Raghu Krishnapuram***
- Traffic Analytics framework and dataset for Indian roads using a Monocular Surveillance Camera Network

Flux Auto *Sep 2017 - Feb 2018*
Self-Driving Engineer
- Pedestrian and lane detection to achieve Level 3 autonomy for trucks in a controlled environment. Also, worked on the Over-The-Air Update infrastructure

ECI Telecom *Mar 2017 - Nov 2017*
R&D Software Engineer
- Automation frameworks and testbeds for involved optical networks. Worked on aspects of Add-Drop Multiplexers, Network Distribution Cards and Ethernet Layer 2 functionalities.

RELEVANT PUBLICATIONS

IEEE ICIP 2025 (In Progress)

Exploting Inter-frame redundacies of Spherical Harmonic Grids for 3DGS Size Reduction

IEEE MMSP 2024

Image Quality Estimation for End-to-end Face Analytics Systems

EURASIP, "Video Coding for Machines", Image and Video Processing Journal, 2024

Task-Aware Image Quality Estimators for Face Detection

IEEE International Conference on Multimedia and Expo, 2024

NeRVA - Neural Field Representations for Joint Modelling of Video and Audio (Patent Pending)

IEEE Multimedia Signal Processing, 2023

Gallery-Query Protocol for Evaluating Face Image Quality Metrics

Electronic Imaging: Autonomous Vehicles and Machines, 2023

End-to-end Evaluation of Practical Video Analytics Systems for Face Detection and Recognition

IEEE International Conference on Image Processing, ICIP 2022

Video-Analytics Task-aware Quad-Tree Partitioning and Quantization for HEVC

IEEE Multimedia Information Processing and Retrieval, MIPR 2022

Evaluating Image Quality Estimators for Face Matching

IEEE Southwest Symposium on Image Analysis and Interpretation, SSIAI 2020

Animal Localization in Camera-Trap Images with Complex Backgrounds

Zenodo, 2018

MV-Tractus: A simple and fast tool to extract motion vectors from H.264 encoded video streams

IEEE International Conference on Computing Communication and Networking Technologies, ICCNT 2018

Detection of Anomalous Behaviour in Crowds Using Newton Pratt's Curve Fitting Technique

IEEE International Conference on Recent Trends in Computational Engineering & Technologies, 2017

Performance Evaluation of Cryptographic Ciphers On IoT Devices

Cyber-Physical Systems Symposium, 2018

Posters on "Video analytics for traffic modelling" and "Video IoT: Unleashing the potential of video for smart cities".