Varun Sundar

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EDUCATION

Indian Institute of Technology Madras, **Chennai**
B. Tech (Hons.) Electrical Engineering *2016 - Present*
Department Rank: 4 of 154 CGPA: 9.61/10.00

AWARDS & HONOURS

- **One of 30** students out of 1,000+ applicants selected under the **IUSSTF-Viterbi REU**. Mentored for a period of 11 weeks under Prof. Ram Nevatia, IRIS Lab, University of Southern Califronia.
- Regional finalist at the **HULT Prize 2018**, dubbed as the *"Nobel Prize for Students"* for work on **Waste Segregation and Management** in Chennai.
- Invited to **Global Entrepreneurship Summit 2018, Hyderabad** under the "*young innovators*" category.
- Secured **All India Rank of 2917** in Joint Entrance Examination (JEE) - Advanced 2016 (out of1 ,50,000+ candidates) and **All India Rank of 501** in JEE-Mains 2016 (out of 13,00,000+ candidates)
- Awarded **KVPY Scholarship** (top-1 % out of 10,000 applicants) and offered provisional admission to IISc with fellowship in 2016.
- Top-1 (out of 35,000 students) in the **National Chemistry Olympiad and National Physics Olympiad 2016** and qualified for the Indian National Chemistry Olympiad **(INChO)** and Indian National Physics Olympiad **(INPhO)** 2016.
- **Special Mention** at the Indian National Mathematical Olympiad (INMO) 2015 (among the top 33 in the country).
- Selected for the **Infosys Catch them Young** (CTY) Programme, 2014 (one of 30 out of 3000+).

RELEVANT COURSEWORK

- Computational Photography [1]
- Reinforcement learning [1]
- Deep learning [1]
- GPU Programming [1] [2]
- Advances in the theory of Deep Learning [1]
- Simultaneous Localisation and Mapping (SLAM) [3]
- Multi-Armed Bandits [1]
- Estimation Theory [1]
- Computer Vision [1] [2]
- Convex Optimisation [1]

RESEARCH EXPERIENCE

Attribute Transfer in GANs *Guide:* Prof. AN Rajagopalan
Image Processing and Computer Vision Lab, IIT Madras *Mar 2019 - Present*

- Developing a GAN-centric approach in transferring unseen attributes from a source to a target dataset.
- Working in the context of image manipulation using natural language, while preserving faithfulness.

MRAS Bandits *Guide:* Prof. LA Prashanth
DON Lab, IIT Madras *Aug 2019 - Present*

[1] Graduate level course.
[2] Indicates Courses audited.
[3] Taken under *EE4801: Self Study.*

- Formulated novel bandit algorithms inspired by **Model Reference Adaptive Search** (MRAS) optimisation methods in control theory under the scenarios of **Regret Minimisation** and **Best Arm Identification**.
- Demonstrated superior empirical performance compared to **Upper Confidence Bounds** (UCB) based strategies. Currently proving finite time bounds for both scenarios.

Decoupling Attributes from Object features *Guide:* Prof. Ram Nevatia
IRIS Lab, University of Southern California *May 2019 - July 2019*

- Experimented with various models of decoupling attribute and object features in order to analyse the dependence on **contextuality** and **compositionality** properties.
- Added an attribute head to Faster RCNN (FRCNN), a state of the art object detector and demonstrated these properties on the **Genome Visual Answering**. Obtained an **object mAP of 15.6** and **attribute mAP of 10.2**.
- Presented at the Viterbi- IUSSTF [4] REU Seminar. Technical report may be found here.

Image Recovery for FlatCam *Guide:* Prof. Kaushik Mitra
Computational Imaging Lab, IIT Madras *Mar 2019 - June 2019*

- Formulated image recovery models for phase mask based FlatCamera. FlatCamera is a lensless based image capturing system which exposes the sensor to illumination under a mask.
- Proposed Global Convolution based models to undistort raw measurements. Compared approaches by utilising metrics of **PSNR, structure similarity (SSIM) and inception score (FID)**.
- Technical report may be found here.

Depth Estimation for Monocular FishEye Images
Valeo, Germany *Nov 2019 - Feb 2019*

- Objective of developing depth estimation deep networks for fish eye images, which have seen a recent surge in application for various computer vision tasks.
- Developed Euclidean distance based depth estimation as opposed to earlier disparity based methods. Trained to output depth maps on the KITTI[5] dataset under the self-supervision regime.
- Worked on incorporating multiple distortion models; including the common polynomial **radial distortion** model, the Scaramuzza model and the **OCAM** model.

PROJECTS

Autograd based Direct SLAM Pipeline Github
IIT Madras *Aug 2019 - Present*

- Working on reformulating LSD SLAM in order to utilise automatic differentiation in comparison to existing numerical derivatives. Framework is based on *Pytorch*, allowing for usage of deep learning based monocular depth maps for initialisation.
- Proposal document may be found here.

Automatic Waste Segregator News Article
Chennai *Aug 2017 - Jan 2019*

- Designed the deep learning backend and fabricated electronics for creating a low-cost, **fast response segregator at source**. Used an ensemble of visual and electrical features to accurately classify over 4,000 distinct objects into a given set of classes.
- Compiled a resource optimised version of tensorflow to deploy on low-power AMD7 architecture Single Board Computers.

[4] Indo-US Science and Technology Forum
[5] KITTI Vision Benchmark Suite, link.

- Won the campus round of the **9th HULT Prize** a $ 1 million challenge to solve the world's most pressing issues by using energy to transform the lives of 10 million+ people, dubbed as the "Nobel Prize for Students". Shortlisted for the regional round at **Nanyang Technological University (NTU), Singapore**.
- Awarded R&D Grant under **Carbon Zero Challenge 2019** in association with the **US Consulate** to develop automatic segregation on larger municipal scales. Demonstrated initial prototype at **7th Inter IIT Tech Meet, IIT Bombay, 2019**.
- Awarded **Best Research Presentation** at **Shaastra 2018**.

Simulating LiDAR Point Clouds from OpenDRIVE Layouts Blog Post
Dailmer, MBRDI, Bangalore *Dec 2018 - Jan 2019*

- Worked on simulating LiDAR Point clouds given a specific **OpenDRIVE** file, comprising of road layouts, present objects and reflectivity coefficients. Utilised the **CARLA simulation engine** [6] in order to model the given OpenDRIVE layout. Proposed scheme to map camera points to a simulated rotating LiDAR, accounting for range, attenuation and vertical Field of View (FoV).
- Demonstrated ability to use concepts from traditional 2D imaging such as segmentation and detection in order to improve simulation outputs.
- Technical report of solution may be found here. Final presentation at MBRDI may be found here, with visualisations here.

Survey of Deep RL Algorithms for Near Real Scenarios
Course Project under Prof. LA Prashanth, IIT Madras *Oct 2018 - Nov 2018*

- Defined 3 contexts for evaluating performance of various RL Agents: **MuJoCo** based physics simulation, car steering in **CARLA** and drone navigation in **AirSim**.
- Compared various Deep RL algorithms such as **DQN, DDQN** and **A3C**. Considered different state space formulations in order to understand the impact on Deep RL agents. Benchmarked performance in the latter two contexts against hand-engineered modular control pipelines (MCP).
- Showed that depending on the state space formulation, MCP can outdo RL agents, especially when engineered with correct prior assumptions. In particular, showed that Deep RL agents cannot handle extremely large state spaces easily.
- Technical report of solution may be found here.

AI for Bharat: Social Initiative Website
Chennai *Mar 2018 - Aug 2018*

- Worked closely with a team of 6 students guided by professors Pratyush Kumar and Mitesh Khapra in the department of Computer Science, with an objective of building social impact solutions to largely out-of-focus problems.
- Aim to democratise benefits of **Artificial Intelligence and Computer Vision** to a broader, unknown rural audience by applying deep learning solutions in an Indian context.

Fiducial Localisation in MRI Scans GitLab
Chennai *Oct 2017 - Jan 2018*

- Worked on autonomous and unsupervised detection of fiducials implanted for brain surgery. Utilised **mayavi** and **VTK** to perform 3-D visualisation of skull images, followed by **PCL** methods for KD-Tree objects, 3-D template matching, and local clustering.

[6] CARLA: Opensource simulator for autonomous driving.

- Documented Deep Learning methods to perform fiducial isolation based on rendered data augmentation, with 3-D convnets and slices for 2-D convnets.
- Taken up as a part of the **Bhabha Atomic Research Centre (BARC)** problem statement during the **6th Inter IIT Tech Meet**.

PROFESSIONAL EXPERIENCE

Deep Learning Engineer, Hyperverge Inc.
Bangalore *May - July 2018*

- Worked on building an end-to-end pipeline for training small scale object detectors on over 13 architectures for the specific case of satellite imagery.
- Achieved a **mAP of 67.4** with a hybrid architecture involving atrous convolutions, and **nasnet** feature-extractors. Used a version controlled system to record deep learning experiments.
- Designed a bootstrapping system utilising fast-inference based on **tensorrt**. Pipeline was designed to work on parallel ETL (Extract Transform Load) for training, interleaved synchronous evaluation and on the run visualisations.
- Designed visualisation metrics for large-scale satellite data (in Tb) on **mercaptor** based tools such as Google maps while using libraries such as **rtree, fastKML** in order to facilitate scalable human-annotation.

POSITIONS OF RESPONSIBILITY

Head, Task force for KAIST - IITM student collaboration
IIT Madras *Nov 2018 - Present*

Leading a task force of 14 students to draft goals and region-centric research agendae for joint undergraduate research collaboration with **Korean Advanced Institute of Science and Technology (KAIST)**.

Head, Computer Vision and Intelligence Group **Webpage**
IIT Madras *Mar 2018 - Feb 2019*

Lead an undergrad community of 40 students who work enthusiastically towards building a impactfull organisation. Have conducted open sessions for an audience of 200+ strong multiple times in IIT Madras and a few outside. Frequently interact with startups (Hyperverge Inc, Detect Technologies, Verihelp,etc), companies (ITC, Google India), NGOs and professors in our activities and projects.

ADDITIONAL ACTIVITIES

- Conducted an introductory session on **Git** and **Version Control** at the 5G Testbed, IIT Madras headed by Prof. R Ganti. Content used may be found here.
- Delivered a workshop lecture at PySangamam 2018 on **data-driven computer vision**. Slides may be found here. Associated blog post maybe found here.