Application for MSc in Computing (Visual Computing and Robotics)

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"Congratulations on getting your **research paper accepted** at **IEEE ICACCP** 2019" was the email which reflected that walking the extra mile for **research**, beyond the realm of my curriculum and interning at Invento Robotics was fruitful. Having a paper accepted at IEEE ICACCP which has a mere **acceptance rate of 26%** motivated me to further work on Computer Vision and Robotics. This paper helped me bag the position of a **Research Intern** at the much-coveted **Georgia Institute of Technology**, Atlanta. I also filed a **patent** for an IoT and Vision-based prototype for a widespread problem of physical abuse. This illustrates my passion for pursuing research to create a global impact and this resonates with Imperial's vision of being a research university to create impact. I would like to delve deeper in the field of Visual Computing and Robotics for which I am seeking admission at Imperial's reputed Computer Science Graduate program.

I utilized the summer break of my freshman year to **intern** at SRISTI-UNICEF under the able guidance of Dr.Anil Kumar Gupta at the **National Innovation Foundation, Government of India**. SRISTI allowed me to connect with farmers and discuss parameters affecting crop yield in Gujarat, India. At the end of this internship, I **lead** interns from various engineering colleges in India, to develop an android application ("GrowCrop") for yield management using Google's firebase as its backend. **Empathizing with farmers**, we noticed another intricate problem they faced which is animals vandalizing crops. We started exploring Computer Vision solutions to deal with this problem. To start off my team **implemented** the Paul Viola and Michel Jones paper 'Rapid Object Detection using a Boosted Cascade of Simple Features' to develop a Haar Cascade suitable for detecting cattle. Tackling detection problems through this algorithm which took only edge and pixel intensities as features were less fruitful as even the slightest change in orientation of cattle proved to be a failure. We noticed we needed to incorporate more features for detection, for which we applied transfer learning on the Faster_RCNN_Resnet model trained initially on the COCO dataset. I used my **academic merit scholarship** at Thapar Institute of Engineering and Technology to rent AWS servers for training neural networks. After training and comparing results over tuned hyperparameters, we **published** our results at TEAMC 2018, an undergraduate research paper conference, where we won the **Best Research Paper.**

I honed my programming skills from the Algorithms course by **Morgan Prize winner, Prof.Daniel M Kane** offered by the **University of California, San Diego** for which I received financial aid. A good grip on Data Structures and Algorithms along with an inclination towards research in Computer Vision has helped me get selected as a summer intern from a pool of bright undergraduate researchers by Mr. Balaji Vishwanathan (**CEO Invento Robotics**) in my sophomore year's summer break. This internship allowed me to get a first-hand experience with 3D mapping using LiDAR and ROS (Robot Operating System). The robots limited hardware did not allow the deployment of dense neural networks and hence initial developers had used Cloud services for object detection. This stack was highly dependent on internet bandwidth and was time-consuming. I was able to achieve a **60% faster** performance than the previously established stack by choosing to train and **deploy** a less dense neural network architecture 'tiny-yolo' for detection making it suitable for embedded systems on Invento's flagship robot 'Mitra'. 'Mitra' is currently used for assisting doctors at various hospitals across India in the fight against COVID-19.

My experience with Computer Vision algorithms on ROS at Invento paved the path for my next **research paper**. We developed algorithms for establishing navigation on robots using Neural Network outputs and communicating them via ROS framework through various nodes of a robot we developed. We **published**

the performance of our algorithm at **IEEE ICACCP 2019** where we **won the Best Research Paper (**Neural Network and ROS based Threat Detection and Patrolling Assistance: Sai Siddartha, Tanuj, Sachin, IEEE ICACCP 2019**)** under the computer vision and robotics category.

The NFHS-4 quotes that nearly 30% of women in the age group 15-49 in India have experienced physical violence. The team of undergraduate researchers I am currently leading ('Team Impact') at Thapar, wanted to explore technical solutions to this problem. We developed a cognitive textile that used Computer Vision for the **first time** to tackle such abuse against women by analyzing live camera feed through cameras embedded in it. This IoT and AI prototype has been filed for an Indian **Patent (**A personal safety device and method thereof**)** bearing application number 201911005811 and is an **accepted entry** at the prestigious **Sir James Dyson Design Challenge**. This patent is a reflection of my vision of amalgamating technology and research for solving real-world problems.

I shared my paper at IEEE ICACCP 2019 with Prof. Yi-Chang (James) Tsai, who then offered me a Computer Vision **summer research internship** (funded) at **GeorgiaTech, Atlanta**. During this internship, I applied the concept of perspective transform suitable for United States interstate roads for traffic sign depth estimation through a **single 2D image**. I was able to **reduce memory consumption by 50%** than the regularly used triangulation method which requires two images. One of my novel **research outcomes** as a result of this internship was that I managed to develop a 2D image and 3D LiDAR point cloud registration algorithm by using a **data structure** called **KD-Tree**. This leads to enhanced performance compared to existing work on huge LiDAR point clouds. By thresholding the LiDAR point clouds retro intensity values, I was able to accurately estimate the health of all traffic signs over the entire length of any interstate. Implementing clustering techniques such as HDBSCAN for GPS points instead of the conventional K-Means and DBSCAN allowed to eliminate computations on bogus LiDAR points making runtime quicker.

For the spring of 2020, I was a **research intern** at the prestigious **Indian Institute of Science, Bangalore (IISc)** under Prof. Yogesh Simmhan dealing with computer vision techniques on drone feed. Here, I developed multiple algorithms to determine image similarity and reduce computational cost on object detection models. During this internship, my team has developed object detection models which work over shuffled color schemes. This development was done to aid the ongoing research trend of performing object detection on encrypted images. During the course of this internship, I have been able to submit papers of my work to **ACM Multimedia** 2020 (in review) and **IEEE GLOBECOM** 2020 (in review). With the rise in COVID-19 cases in India, I was part of the 'GoCoronaGo' application development. Here we built a privacy-respecting contact tracing application. Unlike regular contract tracing applications which work on the edge, we built a centralized contact tracing application, which works on generating network graphs. Treating the problem of contract tracing as a graph makes it easier to query N-hop neighbors for every vertex making it rapid to identify and quarantine people. This app is currently being used by all the students in IISc and has also been featured in multiple leading media outlets across the country.

Imperial is a place where research meets empathy and compassion and it has impacted millions of lives around the globe. My previous experiences, research papers and internships align strongly with the Visual Computing and Robotics program at Imperial. An admit to Imperial will give me an opportunity of working with a diverse peer group under the able guidance of elite professors and undertake research in vision and robotics to develop solutions for global problems. I see myself in the future as a Doctoral Student part of research labs or academia to pursue research for overcoming challenges through technology and ensure that research results are not confined to journals and conferences but reach masses.