Application for MS in Computer Science (Artificial Intelligence) at USC

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"Congratulations on getting your **research paper accepted** at **IEEE ICACCP** 2019" was an email that reflected the quality of my work as an **Intern** at Invento Robotics. Having a paper accepted at IEEE ICACCP which has a mere **acceptance rate of 26%** motivated me to further work on 3D Point Clouds and Computer Vision. This work helped me bag a **Research Internship** at the much-coveted **Georgia Institute of Technology**, Atlanta. Research has always excited me and for my internship semester (Spring 2020) I have been accepted as a semester **Research Intern** at the **Indian Insitute of Science,** Bangalore under the able guidance of **Prof. Yogesh Simmhan** who previously was the **Associate Director, Center for Energy Informatics**, **University of South California, Los Angeles**. After multiple interactions with him and interviews, I was able to understand the research culture at USC and how an admit at USC would reinforce my research pursuits.

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 was 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** and Coursera 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 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 navigation by travelers at the Indira Gandhi International Airport, New Delhi, India and uses detection algorithms that I had developed during this internship.

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 robot's kinematics were inspired by NASA's Martian rover known as the rocker-bogie system and is extremely suitable for healthcare and emergency response systems currently being developed by **Prof. Maja Matarić**'s team **at the Interaction Lab, USC**.

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**. Exploring ongoing research at USC through faculty pages, I noticed research work I undertook at GerogiaTech, closely resembles with work being done at the **ACT lab under Prof. Nora Ayanian at USC** on scene interpretation and identifying object properties. 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 outcome** 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. I am curious to know about how the reconstruction of scenes using a sequence of monocular images would result in while using SLAM techniques such as the ORB-SLAM2. An admit at USC would allow me to pick courses such as **CSCI 545 or CSCI 677** to seek answers to such questions and discuss the same with Prof. Nora Ayanian.

USC is a place where research meets empathy and compassion and has impacted millions of lives around the globe. Having a fantastic peer group and elite set of professors to learn from an admit to USC will augment my passion to undertake research in AI and to develop solutions for global problems. In the long run, I look to be part of research labs or academia to pursue research in dealing with problems that can be solved through technology and AI and ensure research results are not confined to journals and conferences but reach people.