Application for MS in Artificial Intelligence and Innovation at CMU

Name: Sai Siddartha Maram | Email ID: msaisiddartha1@gmail.com

"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. This work 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 Artificial Intelligence prototype for a widespread problem of physical abuse. This illustrates my passion for pursuing research to create a global impact and this resonates with MSAII's vision of creating global impact through innovation and research in AI. I would like to delve deeper into the field of Computer Vision and Artificial Intelligence for which I am seeking admission at CMU's Graduate program in Artificial Intelligence and Innovation.

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** 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 I think such a system that infuses AI with complex kinematics would be a great fit in agricultural pursuits.

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 bringing out innovative solutions 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 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. Courses in the MSAII program allow me to pick electives such as **16-320 and 16-824** which allow me to gain a deeper understanding of Visual perception and strengthing my skills in Computer Vision. I always felt I have been working hard on ideation, research and developing products but have never been able to take products I developed into the market, courses such as **11-651 and 11-654** seem the way for me to step out and actually push my **research and innovations into the market**.

For the spring of 2020, I will be interning as a **research intern** at the prestigious **Indian Institute of Science, Bangalore** under Prof. Yogesh Simmhan dealing with computer vision techniques on drone feed. CMU is a place where research meets empathy and compassion and it has impacted millions of lives around the globe. An admit to CMU will give me an opportunity of working with a diverse peer group under the able guidance of elite professors and undertake research in AI to develop innovative solutions for global problems. I see myself as a part of research labs in the industry to pursue research for overcoming challenges through technology and ensure that research results are not confined to journals and conferences but reach masses.