Statement of Intent for MS in CS at UBC

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Research Interests and Background

"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 3D perception. 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 Computer Vision prototype for a widespread problem of physical abuse. This illustrates my passion for pursuing research to create a global impact and this resonates with UBC's vision of being a research university to create global impact. I would like to delve deeper into the field of **Computer Vision and Artificial Intelligence** for which I am seeking admission at UBC's reputed Computer Science Graduate program.

I got selected as a Summer Intern 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. Cricket is a sport that has always fascinated me. With leagues like "Global T20" emerging in Canada, cricket is a fast-growing sport in Canada. Having followed **Prof. Helge Rhodin's** work on pose estimation at ICCV 2019 I look to work with him to develop textile embedded cameras which would be using AI models (similar to those I developed at Invento) for pose estimation to capture cricket/tennis/hockey postures and help in coaching, technique correction and audience engagement.

I shared my paper at IEEE ICACCP 2019 with Prof. Yi-Chang 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. I am really curious to see how 2D images and 3D LiDAR point clouds could be used for scene reconstruction using SLAM techniques and work with **Prof. Leonid Sigal's** whose work on layout reconstruction using bounding boxes and scene interpretation aligns strongly with my interests. **Prof. James Little's** work on sports analytics and LiDAR-based property estimation is very aligned to my research at GeorgiaTech.

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. UBC is a place where research meets empathy and compassion and it has impacted millions of lives around the globe. An admit to UBC's MS in CS program will give me an opportunity of working with a diverse peer group under the able guidance of elite professors which will well equip me for my Ph.D. I see myself as a 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.

Part 2: Publications and Patents

1. Conference: **IEEE ICACCP 2019**
   Title: Neural Network and ROS based Threat Detection and Patrolling Assistance
   Link**:** https://ieeexplore.ieee.org/document/8883008
   Authors: Sai Siddartha Maram, Tanuj Vishnoi, Sachin Pandey
   Pages: 5
   Published: November 2019
   Award: **Best Research Paper**
   UBC Faculty Research Alignment: Prof. James Little, Prof. Helge Rhodin, Prof. Leonid Sigal

Experience with Computer Vision algorithms on ROS at Invento paved the path for the **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 managed to treat Neural Networks as a ROS node and communicate its output with the ROS base node. We **published** the performance of our algorithm at **IEEE ICACCP 2019** where we **won the Best Research Paper** under the computer vision and robotics category.

2. **Patent**: Government of India (Published)
   Title: A personal safety device and method thereof
   Application Number: 201911005811
   Published: February 2019
   UBC Faculty Research Alignment: Prof. Cristina Conati, Prof. Sidney Fels

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.

3. Conference: **TEAMC 2018**
   Title: Neural Network based Object Detection Design for Crop Vandalism
   Link:
   https://www.researchgate.net/publication/324278748_Neural_Network_based_Object_Detection_Design_for_Crop_Vandalism
   Authors: Sai Siddartha Maram, Tanuj Vishnoi, Sachin Pandey

Pages: 9
Published: March 2018
Awards: **Best Research Paper**
UBC Faculty Research Alignment: Prof. Leonid Sigal

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 problems faced by them. **Empathizing with farmers**, we noticed animals vandalizing crops is a major problem. 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. 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.**

Part 3: Honors, Scholarships, Fellowships, and Awards

1. **Complete Academic Merit Scholarship, Thapar Insitute of Engineering and Technology**

Having a score of 97.9/100 during my 12th grade and CGPA of 8.94 at Thapar Institute of Engineering and Technology, I am a recipient of the complete academic merit scholarship which covers my tuition and boarding for undergraduate. Only 11 students have been able to uphold the scholarship across all departments in the institute.

2. **Government of India and Government of Sikkim, IEEE ICACCP Travel Grant**

My team was awarded a travel grant for presenting our research paper at the IEEE ICACCP 2019. We were awarded the travel grant based on the quality of our research outcomes and impact on society.

3. **Hackathon Wins**

    a. Winner, Udacity-Octahacks, Chitakara University
    b. Winner, Start-up Expo, Thapar Insitute of Engineering and Technology
    c. First Runners-up, UHacks