Personal Statement

We are currently at the brink of a technological breakthrough in terms of Robotics, and I strongly believe that we require robots that are smart and powerful to tackle the challenges of everyday life.

To answer the question "Why Robotics?"

In all candor my passion for engineering has not been limited to my chosen field; rather I like to dabble in and try various other fields that fascinate me. I always have actively initiated several projects to better my understanding on a particular topic, like building an ATV two seater vehicle (was the captain of 20-member team) right from scratch or being a part of project to check the efficiency of solar panel installed in the college or being a part of research on Nano-material behavior among others. During 6th semester of my undergraduate studies I was introduced to the world of robotics through an amazing seminar which changed my perspective. I was very adamant on giving this field an honest try. As I started learning robotics I was just simply astounded with how different fields of engineering and some mathematical models can come together to produce a technology so sophisticated, practical and revolutionary. I wanted to know more to see how intelligence in a hardware could affect things around, changing the course of the world and the immense potential it had to offer. With further exploration and study I saw how robotics is taking steps in solving the major problems world is facing. For instance, how an un-manned rover could go to mars for surveillance, site mapping and collection of data or how the co-ordination of number of micro robots can help in rescue mission etc. I also wanted to know how smart machines can enhance the capabilities of humans. Now in all confidence I would dedicate myself in pursuit of Robotics.

Another reason that paved my ambitions was the concern for environment. To see the glaciers melting faster than ever really affirmed the effects of catastrophic problems such as global warming. After witnessing such remarkable advancement (through articles) I was convinced that to tackle such problems, intelligent technologies are required; and I ask myself how can I contribute and be a part of this global cause? This constantly motivates me to acquire high quality skills and knowledge.

I started with a comprehensive course on Edx (Micromasters Robotics and ROS) and completed the entire course investing a lot of time brainstorming through every assignment. I have always been intuitive with mathematics so many concepts came naturally. The course gave me a nice overview to the fundamentals of robotics following which, I took a major project with a belief of gaining practical experience and commitment to see it through. The major tool in my arsenal was proficiency in computer languages such as python and C/C++, and I have a good understanding of embedded system due to a lot of hands on projects I did; like animatronic hand and Bluetooth remote control car. Even though I did my undergraduate studies in mechanical engineering my focus was always on being an interdisciplinary engineer.

My final project in B.E was a combination of the two major projects I did in Robotics with a plan to combine their working, viz-a-viz smart mobile rover with a mounted robotic arm (designed in SOLIDWORKS 2017). Initially the inverse kinematics was solved using geometric approach but later on as my concepts got better I could solve it using algebraic approach (matrix made using dh parameters). The main idea was to do the real time mapping and navigation while avoiding the obstacles along with pick and place operation which can and also be used for multiple other applications (since the robotic arm was 5 DOF for better dexterity). Later to expand the horizon of project, object detection (SIFT) was also implemented as a future planning that robot would capture the co-ordinates of the trained object (still working on it). I knew that it was a lot of work for a given time span of one year, nonetheless I saw it through while still working on it to deepen my understanding of the field.

With the project being self-funded and guided through self-research, setbacks and obstacles to overcome were anticipated in plenty. To list out a few…

The robotic arm where Denavit Hartenburg parameters were used for the precise calculations for inverse kinematics, the design was made taking torque calculations into consideration. Despite that the base link motor was failing due to high impulse even though the servo motor used was MG 995 (13kg-cm torque). Giving the vertical frame an angle proved to be an easy and efficient fix as the weight was being distributed to the cosine component as well. The opposite side was compensated by orientation of the rover.

A very common ROS package was used to turn depth point cloud produced by an available Kinect Camera into a laser, instead of LIDAR laser scanner due to monetary constraints. Thus the scan message was given in the form of fake laser. Raspberry pi was used as micro-controller and thanks to features of ROS I was able to share the computing power with my laptop.

Furthermore, a number of attempts were made to write a decent code to minimize the errors in accuracy of the odometery value for both navigation and SLAM (since it's working on differential drive thus slip was an issue). Currently, I am in the process of adding kalman filter (landmark covariance) in order to have a better feedback system.

The blind spot of Kinect Camera was up to 35 cm and since the rover was small and compact the arm attached did not have additional reach. The whole idea was to completely automate the robot. The camera was fixed at a diagonal height giving more space and arm's co-ordinates was stored using tf library (transform co-ordinates). Thus the captured co-ordinates were transformed to arm's location.

From each challenge I have learnt something new and every solution has inspired me with more ideas. The more efforts I put into my work, the clearer my further journey and ambitions have become. I would like to highlight while working on my two projects I learnt a variety of concepts ranging from inverse kinematics to understanding mathematical models such as quaternions to path planning algorithms such as Dijkstra and A star and can say in confidence that I have grasped these concepts on a

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fundamental level because these varied ideas were the key concepts to my project and the success of my project was essential.

I have always believed that extracurricular activities contribute to the all-round development on an individual's personality. During college, I was the Captain of the Table Tennis Team for three years, and was also a seeded state player for this sport. I have also secured the Blue-1 Belt in Taekwondo, and these sports have helped me the art of being persistent and consistent. On top of that I am fluent in keyboard and can play minor pieces of Chopin and Rachmaninoff.

I have learnt a lot in my undergraduate studies and no matter the circumstances have always produced the best results possible. The reason I chose the *University of Colorado Boulder* for my graduate studies is because I strongly believe with the help of your superior faculty, well interconnected student community, and state of the art robotics equipment I can make the best of my abilities, contribute for the environment and make my life worthwhile. My research interest is split between two sub-fields of **Robotics – swarm robotics and autonomous navigation.** I am very much interested on working with *Professor Violet F. Mwaffo*. Reading his paper on *Design and characterization of a miniature free-swimming robotic fish based on multi-material 3D printing* is what led me to apply to the **University of Colorado Boulder**. I was amazed to see how robotics has advanced to be able to mimic the movement of fish by creating a similar prototype. I spent a lot of time in understanding the paper and it deeply encouraged me to be a part of the research work of Professor Violet. Further reading about the research interest of the Professor such as *autonomous swarm robotics,* I was convinced this was the field I want to pursue as it will definitely have a huge impact such as in rescue missions and environmental protection. I truly believe that being a part of **University of Colorado Boulder** will further my knowledge and I will be a valuable asset to the University. If selected I will be the first person in my entire family ever to pursue higher studies that too in such a prestigious and diverse university. I have browsed the campus photos of **University of Colorado Boulder** a thousand times and it motivates me to envision myself in such a wonderful campus. With my past experience and diligence in research I hope that admission committee will place their trust in my abilities as a prospective student.