**STATEMENT OF PURPOSE   
 Piyush Khopkar**

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One of the important events that instilled curiosity for space science in my life was when my father took me to watch a meteor shower. This event left an inquisitiveness in my mind to know more about the universe. Since then, I have been continuously working to gain knowledge and contribute to the space science community. I am interested in the PhD program to prepare myself for a career in research and development in space systems engineering. My motivation for the doctoral studies stems from my volunteering experience with MOXIE (the Mars Oxygen In-Situ Resource Utilization Experiment), a Mars 2020 payload, as a Technical Staff and with Blue Marble Space Institute of Science (BMSIS) as a Volunteer Research Assistant. The goal I have for this next chapter in my life is to gain expertise and establish credibility in spacecraft software, dynamics and control for designing advanced space system technologies.

I believe research is an important tool to harness innovation. My first research proposal was an idea for converting sound vibrations into electricity when I was 16 years old. I sent this proposal to the then President of India and Scientist Dr. Abdul Kalam. I received a letter of appreciation for this proposal which inspired me towards research. Since then, I have been an active participant in research for space sciences. I would give credit to my time management skills that help me to continue working on volunteering projects for the last three years while working a fulltime job. This has allowed me to be committed to following my passion. As a result, the volunteering work for the space science community has given me a sense of accomplishment and sparked my interest in higher education.

I actively participate in space science conferences to gain insight on missions. I was introduced to the MOXIE project at Dr. Michael Hecht’s talk at the Mars Society’s convention in 2015. MOXIE’s concept of In-Situ Resource Utilization (ISRU) of Martian carbon dioxide to generate oxygen intrigued me. I was curious to learn more about MOXIE and I got in touch with Dr. Hecht to express my interest in volunteering. I was fortunate enough to receive this opportunity. Over the past two years, I have contributed in the development of a MATLAB-based GUI to automate MOXIE’s flight dynamic model. The GUI encapsulates the complexities of the dynamic model and automates existing model running and data analysis workflows. This GUI is featured in a recently published paper presented at the IAC conference [1]. I also worked on the development of a fault detection system for MOXIE’s dynamic model. This system enabled MOXIE’s dynamic model to respond to faults caused by anomalies. The new system was helpful to simulate the potential faults in MOXIE on Mars. My work was appreciated by the peer science team members and I was included in the official Mars 2020 Science Team as a Technical Staff. I also received the inventor status on NASA’s New Technology Report through JPL for software creation. This project has been a wonderful learning experience where I worked on a space system project in a development team. The skills I have developed from this project will translate well into my research practices as a PhD student.

I have also volunteered for the Blue Marble Space Institute of Science for research projects titled ‘modeling radiations and its effects on astronaut health’ and ‘understanding the primitive solar system organics by analyzing the organics produced in the laboratory’ [2]. In these projects, I developed simulation models using MATLAB, Python, and Geant4 to analyze the results using ROOT. One of my favorite volunteering roles has been my position as a Solar System Ambassador (SSA) with NASA-JPL. SSA is a program designed to share the latest science and discoveries of NASA missions with the public. I have delivered space science talks on missions such as Cassini Huygens, Juno, and the Mars Exploration Rovers to promote STEM education.

I acquired AI research experience with my master’s degree. My master’s thesis, titled ‘Hyperspectral Unmixing and Band Weighting for Multiple Endmember Sets’, focused on solving problems of Hyperspectral Imaging (HSI) using machine learning techniques. HSI is one of the most widely used spectral imaging techniques for image analysis. It consists of spectral unmixing and dimensionality reduction of hyperspectral data. Many hyperspectral scenes consist of multiple sets of materials; however, the majority of methods are designed for unmixing single sets of materials. I developed unique algorithms for unmixing multiple sets of materials and proposed a new method to combine unmixing with dimensionality reduction [3][4]. Based on my experimental results, the new method was proven to be more efficient as compared to the existing algorithms. The master’s program taught me to follow best practices for successful research, such as thorough literature reviews, a willingness to try new ideas, critical reviewing and thinking, constructive criticism, and documenting findings.

I am currently working full time as Software Engineer in Test-MATLAB Graphics with the MathWorks. I have worked on more than 30 high impact user facing projects, such as plots and animations for data visualization in 2D and 3D coordinates, graphics performance, printing and exporting graphics, and activation functions for deep learning. I developed tests and tools to ensure high quality and high performance of the graphics system. In one of the projects, I collected data and drew inferences, which were then used for project prioritization and design decision making. While fulfilling the responsibilities of this position, I honed my problem analysis, effective communication, and team collaboration skills. I am also co-authoring a book on medical data analysis using MATLAB. I understand that leaving my current job at MathWorks with financial stability and going back to school is a tough decision. I work hard to produce results against all odds and have been successful in juggling multiple tasks with my fulltime job. However, it will be exciting to be able to work towards my goal of doing research in space systems engineering on a fulltime basis through the PhD program. The PhD degree will be of immense help to take me one step closer to my dream of working in space industry.

For the PhD program, I am interested in spaceflight technology research in spacecraft dynamics and software. I have had the privilege to work with Dr. Jeff Hoffman on MOXIE. I would love to contribute towards his research in the future development of MOXIE and in the design of advanced ISRU technologies. I am also interested in Dr. David Miller’s ‘in-orbit estimation of objects’ and distributed space systems, such as his ‘SPHEREs’ research. In particular the ‘in-orbit estimation of object’ research is appealing because of its applications in mining resources from asteroids and defuncting space debris.

In conclusion, I am confident that I will meet expectations for the core requirements of the PhD program from my interdisciplinary skills in software and AI research. It would be an honor to have an opportunity to be considered for the PhD program in the Department of Aeronautics and Astronautics at MIT.

Thank you for your valuable time and kind consideration of my application.

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[1] Hinterman, Eric (2018). Simulating Oxygen Production on Mars for MOXIE (Mars Oxygen In-Situ Resource Utilization Experiment).

[2] C. Giri, **Khopkar,P**., H.J. Cleaves, "Universal Mass Spectrometry-Based Life Detection," Planetary Science Vision 2050 Workshop, NASA Headquarters, Feb 27- March 1 2017  
[3**] Khopkar, P**.(2014)."Hyperspectral Unmixing and Band Weighting for Multiple Endmember

Sets," Master’s Thesis, University of Missouri, Columbia, Missouri, USA

[4] **Khopkar,P**.; Zare, A,"Simultaneous Band-weighting and Spectral Unmixing for Multiple Endmember Sets," Geoscience and Remote Sensing Symposium (IGARSS), 2013 IEEE International ,vol., no., pp.2164,2167, 21-26 July 2013