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 the MOXIE (Mars Oxygen ISRU Experiment, a Mars 2020 payload) as a Technical Staff. My focus is to gain expertise and establish credibility in spacecraft software, dynamics and control for designing advanced space system technologies.

My contribution to the space science community always gives me a sense of accomplishment. One of my favorite volunteering roles is the Solar System Ambassador (SSA) position with NASA-JPL. SSA is a program to share the latest science and discoveries of NASA missions with public. I have delivered space science talks, such as Cassini Huygens, Juno, and Mars Exploration to promote STEM education. I also volunteered for the Blue Marble Space Institute of Science for a research project focusing on ‘modeling radiations and its effects on astronaut health’ and ‘understanding the primitive solar system organics by analyzing the organics produced in the laboratory [1]’. In these projects I developed models using MATLAB, Python, Geant4 and analyzed results using ROOT.

My interest in the space science dates back to my years in high school, when I first learned about the Spirit and Opportunity rovers. I received a letter of appreciation from the then President of India Dr. APJ Abdul Kalam for proposing an idea on ‘converting sound vibrations in to electricity’ in 2004. To gain insight on missions I actively participate in space science conferences. I got to know about MOXIE from Dr. Hecht’s talk at the Mars Society’s convention in 2015. MOXIE’s concept of In-Situ Resource Utilization (ISRU) of Martian carbon-dioxide and generating oxygen from it 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. I contributed in the development of a MATLAB based GUI to automate the MOXIE’s flight dynamic model. The GUI encapsulated the complexities of the dynamic model and automated existing model running and data analysis workflows. This GUI is featured in a recently published paper presented in the IAC conference [2]. I also worked on the development of fault detection system for MOXIE’s dynamic model. The fault detection system enabled MOXIE’s dynamic model to respond to faults caused from anomalies in it. 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 the 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.

I am currently working full time as Graphics Quality Engineer with the MathWorks. I have worked on more than 30 high impact user facing projects in the MATLAB, 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, critical thinking, effective communication, and team coloration skills. I am also co-authoring a book on medical data analysis using MATLAB.

I acquired AI research experience with my master’s degree. My master’s thesis ‘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 widely used spectral imaging techniques for image analysis. HSI consists of spectral unmixing and dimensionality reduction of the hyperspectral data. Many hyperspectral scenes consist of multiple sets of materials; however, majority of methods are designed for unmixing single set of materials. I developed unique algorithms for unmixing for multiple sets of materials and proposed new method to combine unmixing with dimensionality reduction [3][4]. Based on the experimental results, the new method was proved to be more efficient as compared to the existing algorithms. Through the master's program I have learned to follow the best practices for successful research. I also served as the General Secretary of Cultural Association of India to mentor new students.

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 the 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 science on a fulltime basis through the PhD program.

For the PhD program I am interested in spaceflight technology research in spacecraft dynamics and software. I had a privilege to work with Dr. Hoffman on MOXIE and I would love to contribute towards his research in the future development of MOXIE and in design of advanced ISRU technologies. I am also interested in Dr. Miller’s ‘in-orbit estimation of objects’ and ‘SPEHERs’ research.

In closing I am confident that I will meet expectations for the core requirements of 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 the MIT.

Thank you for your time and consideration of my application.

[1] 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

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