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Enabling a New Age in Spaceflight and Space Exploration Through Space Traffic Management and Autonomous Space Systems

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Abstract
Space flight is entering a period of renaissance with considerable change in the perception of what humanity's role in space will be. Recently, SpaceX and OneWeb have proposed mega satellite constellations of up to 4,425 satellites in Low Earth Orbit (LEO), which will more than double the number of satellites currently in LEO. These constellations have the potential to revolutionize the telecommunication industry by providing complete global internet coverage. The economic gains of completely connecting rural areas and developing nations cannot be understated, however, the current space infrastructure is not capable of handling such a dramatic increase in the number of active satellites. Therefore, there is a critical need for new solutions to the problem of Space Traffic Management (STM) and Space Situational Awareness (SSA).

Conversely, the technologies that are revolutionizing near-Earth spaceflight will provide new opportunities for deep space exploration. Future science-driven interplanetary missions and/or missions to Lagrangian points and asteroids will require advanced guidance and navigation algorithms that are able to adapt to more demanding mission requirements. For example, future missions to asteroids and comets will require that the spacecraft be able to autonomously navigate in uncertain dynamical environments by executing a precise sequence of maneuvers (e.g. hovering, landing, touch-and-go) based on information collected during the close-proximity operations. These missions will require approaches for landing at selected locations with pinpoint accuracy while autonomously flying fuel-efficient trajectories.

This presentation will discuss new methods for enabling STM and autonomous space systems. In particular, this presentation will discuss a new method for assessment of confidence in position knowledge through improved satellite drag modeling, which is critical for STM. This presentation will also discuss novel methods for accurate upper atmospheric density estimation and uncertainty quantification. Furthermore, autonomous space systems and robotic systems can offer new ways of exploring our solar system. Current research on autonomous space systems will also be discussed. Finally, this presentation will provide a vision for the basic research that is needed to enable the future of spaceflight and space exploration.

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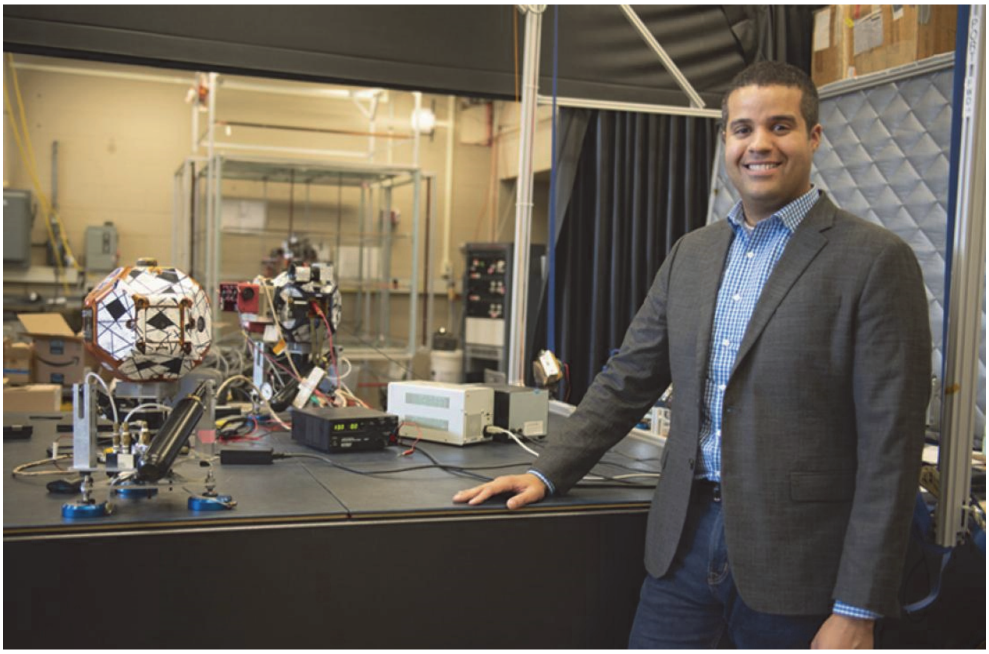
Biographical information



Richard Linares is the Co-Director of the Space Systems Laboratory at MIT and holds a Charles Stark Draper Assistant Professor position at MIT's Department of Aeronautics and Astronautics. Richard Linares joined the Department of Aeronautics and Astronautics in July of 2018. Before joining MIT, he was an Assistant Professor at the University of Minnesota's Aerospace Engineering and Mechanics Department. He received his B.S., M.S. and Ph.D. degrees in aerospace engineering from University at Buffalo, The State University of New York. He was a Director's Postdoctoral Fellow at Los Alamos National Laboratory and also held a postdoctoral associate appointment at the United States Naval Observatory. His research areas are astrodynamics, estimation and controls, satellite guidance and navigation, space situational awareness, and space traffic management. Richard Linares is a recipient of the AFOSR Young Investigator Research Program Award in 2018.

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