Paper ID: 80510
student

IAF SPACE COMMUNICATIONS AND NAVIGATION SYMPOSIUM (B2)
Advances in Space-based Navigation Technologies (1)

Author: Ms. May Hammad
Deep Space Initiative, Canada, may23773@gmail.com

Ms. Menatallh Hammad
Deep Space Initiative, Canada, menahhamad@gmail.com

DEEP LEARNING BASED APPROACH FOR VISION BASED SPACECRAFT NAVIGATION AND GUIDANCE FOR ASTEROID EXPLORATION MISSIONS

Abstract

Asteroid exploration is becoming a highly researched topic among an increasing number of engineers and scientists, as more and more exploration spacecrafts are sent into space. Furthermore, autonomous navigation for spacecrafts operating on scientific missions in space becomes significantly a crucial task as the distances between the earth and asteroids become steadily vaster.Nevertheless, currently, the known asteroid-exploring spacecrafts are not set to navigate with full autonomy. For instance, OSIRIS-REx and Hayabusa2 spacecraft don't exhibit full autonomy due to the limitation of the onboard navigation system. Navigation systems are said to be crucial for most spacecraft operations,as it hugely contributes to the determination of the spacecraft states and is mostly responsible for the execution of guidance and control commands and functions. Moreover, autonomous navigation becomes more and more vital for spacecrafts on missions, especially when performing close proximity manoeuvres and operations namely orbiting and landing/touch-and-go operations. Remarkably, the ground-based observation of the asteroid is found to be significantly noninformative, accordingly, the spacecraft shall not obtain a detailed surface map in order to navigate its way through until arrival at the locality of the asteroid target. As a consequence, the spacecraft is required to rely on such a poorly discovered map of the environment for it to perform navigation, or alternatively be able to update its onboard navigation database and estimate its current state in a fully autonomous manner. Accordingly, it is to be investigated in this paper; Artificial intelligence techniques and machine learning can be exploited to develop a state prediction tool as a means to help the spacecraft navigate automatically and maintain fully guided motion based on data gathered from similar past missions. Machine learning (ML) is gathering huge attention recently among engineers to achieve autonomous image-based navigation which is robust against uncertain factors. So in this paper, we would explore image-based AI methods for scene understanding and landmark detection to determine the position and orientation of the spacecraft relative to the asteroid for aided autonomous navigation. This research is performed as a part of the Andromeda research program of the Deep Space Initiative(DSI), a non-profit space research organisation based in Colorado, USA.