Image Correlation in Unknown Environments for OSIRIS-REx Asteroid Sample Collection

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The OSIRIS-REx (Origins Spectral Interpretation Resource Identification and Security-Regolith Explorer) spacecraft launched in September 2016 and will arrive at the asteroid Bennu in December 2018 as part of its mission to rendezvous with the asteroid, navigate to the surface, and collect and return a sample of regolith. Due to the fact that round trip light time at the time of the sample collection is approximately 30 minutes, resulting in long telecommunication delays, the spacecraft must be able to navigate autonomously to the surface. Natural Feature Tracking (NFT) is a subsystem designed to autonomously provide orbit state updates during the sample collection descent by correlating onboard camera images with features rendered to reflect the expected surface appearance. The feature data is generated from a shape model of the asteroid created using science data collected during earlier phases of the mission.

One of the major challenges of NFT is that there is no way to test these shape model features against all NFT image conditions until NFT is being used to perform the sample collection. This is especially challenging due to the wide range of lighting conditions and image resolutions along the descent profile. As a result, significant testing must be performed ahead of time to ensure that shape model features will reliably correlate against NFT images. Since the spacecraft has not yet reached Bennu and therefore the asteroid surface is still unknown, all testing to date has been performed with simulated imagery leveraging a simulated asteroid shape model.

In preparation for arrival at the asteroid and ensuring that NFT selects the most reliable features, this presentation will discuss the lessons learned from all NFT image correlation analysis performed to date. This includes features generated from Stereophotoclinometry (SPC) for building the shape model as well as results from different types of surface features, insight into what makes a reliable feature, and performance impacts of the different image conditions expected for NFT. In addition to lessons learned, this presentation will also outline the unknown performance impacts that have yet to be investigated, including the gap between simulated and real imagery.