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HYSIM: A TOOL FOR SPACE-TO-SPACE HYPERSPECTRAL RESOLVED IMAGERY

Abstract

Space-to-space inspection of orbiting spacecraft is a possible task for new mission concepts targeting in-orbit servicing. Compared to the standard monochromatic imagery, hyperspectral resolved imagery brings enhanced information helpful in identifying and characterizing surface materials, their status, degradation, or damage on the spacecraft to be inspected.

Despite the recent interest in these new applications, no available tool can simulate and assess the performance of eventual hyperspectral imagers for space-to-space applications. Most of the available tools target Earth or planetary remote sensing applications with the eventual inclusion of atmospheric effects on the simulations, but any of them can directly generate images for space-to-space-based observation scenarios.

We propose to overcome this gap by bringing to the community a new tool, HySim, which allows for simulating hyperspectral space-to-space images under a wide range of possible space-to-space scenarios, such as far fly-bys, close inspection, rendezvous, and proximity operation scenarios. HySim builds on existing open-source tools for defining objects (e.g. CAD or visualization tools) and rendering images. Image rendering is a core capability to cope with multiple reflections (spacecraft often use shiny materials) and is non-trivial for high-quality image simulation. The tool includes ad-hoc build functions for setting up accurate space-to-space imaging scenarios, including specific orbital and illumination conditions, setting up characteristics of the camera system (i.e. resolution, focal length, shutter time and eventual hyperspectral bands used to generate the images) and libraries for characterizing reflectance and emission properties

of the materials of the observed spacecraft. As a result, the tool is able to provide output hyperspectral images of the simulated scene.

The paper outlines the key features and applications of HySim, showing the results of the validation performed through comparison with real hyperspectral and multispectral space-borne images in selected test case scenarios. An overview of the possible applications is also provided at the end of the paper, showing the key capabilities of this tool in numerous analyses and potential applications in future space missions.