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TOWARDS IN-ORBIT HYPERSPECTRAL IMAGING OF SPACE DEBRIS

Abstract

Space-based observations can provide the means to accurately detect, characterise, and track space debris. This paper explores the utility of resolved hyperspectral imaging from a space-based platform. Hyperspectral imaging can provide high spectral resolution observations of objects in orbit. The method has the potential to reveal absorption and emission features, allowing the highest level of material discrimination and identification, resulting in spectral "finger-printing" of a space object. Hyperspectral resolved imaging has the potential to provide an assessment of object composition, object geometry, and object status i.e., whether it is active, inactive, or defunct.

Our work is broadly split into several parts. Firstly, we present results from a lab campaign that performs hyperspectral observations of materials to constitute a material reflectance database. This is followed by the development of a hyperspectral simulator to model realistic space-to-space hyperspectral observations under a wide range of possible scenarios. Example results are presented, including a validation of the simulator through comparison with the ground-truth hyperspectral observations provided by the lab-campaign. We then present a mission design and concept of operations for a space-based hyperspectral imaging mission. Herein, we focus on the applications and theoretical capabilities of space-to-space hyperspectral imaging.

Finally, we conclude on how the synergy between the lab campaign, hyperspectral simulator, and the development of a mission CONOP has enabled detailed assessment of the utility and opportunities of future in-orbit hyperspectral observation missions.