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Limitations of Hyperspectral Earth Observation on Small Satellites

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Abstract

Small satellites offer the means for a consolidated strategy for fast, economical access to space. Their role in national and regional programs is of great value in today's world, as they provide affordable means to obtain remote sensing data. This has proven to be especially useful for developing countries, many of which encompass large and remote expanses of territory. The high degree of development of small satellite technology facilitates increasing capabilities of onboard Earth Observation (EO) sensors. With missions already operating in the high resolution range (< 5 m) and several spectral bands, the performance of these sensors will be soon limited by the laws of physics. Newly envisaged small satellite missions include plans for an increasingly high number of bands – reaching up to hundreds of them – while maintaining good spatial resolution. This imposes a challenge in the coverage, the spatial resolution, and the quality of the data that can be obtained with these systems. In this paper, we analyze the restrictions facing hyperspectral sensors on small platforms caused by the limited volume and power available. The constraints imposed by the physics of optics on the signal-to-noise ratio (SNR) and the modulation transfer function (MTF) are also described, as well as the problems arising from the large amounts of data generated by such missions.

1. Introduction

Although hyperspectral sensors were originally developed for air platforms, spaceborne models are becoming increasingly frequent since the first operative hyperspectral sensor developed for the EO-1 mission (Pearlman et al., 2003). These sensors, typically offering several tens or even hundreds of spectral bands in the VNIR/SWIR/TIR regions, are capable of identifying Earth's soil components and estimating their abundance with a high degree of accuracy. Nevertheless, when adapting these sensors to the small satellite class, several problems arise. The analysis carried out in this article addresses spacecrafts of up to 100 Kg of total mass, thus belonging to the mini/microsatellite class.

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