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AN INTELLIGENT 3U HYPERSPECTRAL EARTH OBSERVATION CUBESAT FOR LOW-COST, DIRECT-TO-GROUND APPLICATIONS

Abstract

Hyperspectral Earth Observation has proven to be of great use for a number of military and civilian applications, providing rich information in a wide range of the electromagnetic spectrum. At the same time, CubeSats are starting to be used in numerous low-cost Earth observation applications.

However, the usual size of hyperspectral sensors together with the vast amount of information to be downloaded and the downlink limitations of nanosatellites normally restrict this capability to larger and more costly satellites. Furthermore, the large data volumes require high-performance antennae on ground. Highly skilled image processing experts are also required to process the images in order to extract useful information products for end users. All these requirements limit the reach of the technology to a reduced number of users.

This project aims to make hyperspectral imagery accessible for some African nations and other communities with limited economic resources and ground infrastructure and expertise. For this purpose, a 3U CubeSat is proposed and given the capacity to perform on-board the image processing tasks traditionally performed on the ground. The CubeSat can be built for under $100 000 and the associated onboard software tools are open source.

The hyperspectral images will be pre-processed and classified with Machine Learning algorithms. The final product will be a compressed, georeferenced GIS map representing only the relevant information for a specific application. Alternatively, the user can download an image in a selected wavelength or the whole hyperspectral data cube.

The core of the software is written in C++ and makes use of the Orfeo ToolBox (OTB), an open-source software library for remote sensing image processing developed by the French Centre National d'Études Spatiales (CNES).

Because of its economic relevance in the African continent, the main focus for potential applications of this system is agricultural monitoring for food security. However, the system could also be tailored for other areas of application.