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ESTIMATION OF WILDFIRE FLAME FRONT SPEED FROM SPACEBORNE MICROBOLOMETERS IN REPLICABLE SATELLITES

Abstract

From ancient 1-km MODIS to modern 370-m VIIRS or 1-km TIRS, all in LEO, to 3-km SEVIRI in GEO, most of thermal spaceborne sensors are serving imagery to support wildfire management activities. However, since ground temperatures are constantly changing and long wavelength detectors become more complex, the advances in technology have not offered a significant operational advantage to firefighters, who systematically claim for more frequent revisits. Only a dedicated constellation seems feasible for this global need, such as FUEGOSAT from ESA two decades ago, which failed to become affordable. Fires are, from a thermal point of view, conspicuous occurrences for infrared channels, so no special sensor quality is required. Nowadays, the uncooled microbolometers have demonstrated to be viable thermal imagers able to fly in small cubesats. Initiatives such as EDF Firesat, JPL Firesat, DLR Tubin, OroraTech, Albedo, Satellite VU and others are showing progress in this direction. However, these sensors have moderate detector pitch sizes and are quite slow, which makes their use in space at the very limit of their feasibility.

This paper explains how to overcome microbolometer constraints and satellite limitations to independently provide an interesting new product: the flame front propagation speed. Two simple, easily replicable satellites in tandem shall evaluate the flame position change to feed fire models. As precursors of a more populated constellation, these extremely simple satellites use an intelligent attitude management to decide the observation plans, the battery charging and the inter-satellite separation control. Besides, the image blurring due to satellite movement can be compensated by synchronising the detector readout with a slow satellite pitch manoeuvre and, possible, a floating cold shutter. Of course, in this simple but pre-operational concept, onboard algorithms will help with image filtering and bandwidth reduction for a quick realtime communication, essential in this application.

The prototypes under development shall be very cost efficient. This includes the use of available microbolometer cameras rugged in house, proprietary attitude control algorithms and extensive use of COTS elements integrated and tested in our facilities. The general architecture, subsystem selection and packing and test plan are detailed in the paper.