IAF EARTH OBSERVATION SYMPOSIUM (B1)
Earth Observation Sensors and Technology (3)

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DESIGN OF HIGH-RESOLUTION SWIR AND MWIR SENSORS FOR OIL AND WATER LEAK DETECTION FROM A SMALL MODULAR LEO SATELLITE

Abstract

Traditionally, the Earth Observation (EO) market relied on governments or international institutions developing their space systems and using EO data for the implementation of their policies. Other than defence or military programmes, the technology developed was aimed at serving weather, environmental management and RD. However, during the last decade, private actors have come into play benefitting from these technological developments and the data collected by the institutional systems as well as an easier and cheaper access to space. These have allowed them to launch their own EO systems. In most cases, these private initiatives rely on spacecraft which range from cubesat (starting at masses below 1 kg) to small satellite (mass up to 500 kg).

Spatial EO systems offer a unique advantage with respect to ground ones; those can collect detailed data from large areas, or even provide world-wide coverage. This is an ideal tool for large infrastructures like oil and water distribution networks, which have in common that they span along thousands of kilometres of pipelines and experience the same issue: leaks of different magnitudes which in many cases are difficult to detect even using the most advanced (and expensive) ground detection systems. The economic impact of these losses in water utilities and oil transportation companies amount to billions of dollars per year. In addition to this financial loss, oil leaks are accompanied with environmental implications and the corresponding fines and recovery cost. Both oil and water sectors are submitted to strong regulatory constraints, especially in America and Europe, which enforce the active leak detection monitoring.

Preliminary studies available suggest that leaks of even small magnitude can be detected using space based infrared sensors. The technique used for the leak detection presented in this paper will be relative thermal inertia for water and relative reflectivity of hydrocarbons for oil. In both cases, “relative” means with respect to the non-leak affected surroundings; in other words, it will be a relative detection. Oil and water responses in the infrared spectra suggest that Short Wavelength Infraed (SWIR) and Medium Wavelength (MWIR) sensors can be used for their detection using remote sensing from space.

This paper describes the specific needs for the mission and the main performance objectives. Then, it presents a sensor design operating in the SWIR and MWIR bands, optimised for oil and water leak detection. This will be operated from a small satellite in LEO.