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Author: Dr. Nicola Palombo Blascetta
Satellogic, Spain, nicola.palombo@satellogic.com

MULTISPECTRAL FILTER-BASED SYSTEM WITH ALBEDO RETRIEVAL FOR METHANE AND CARBON DIOXIDE DETECTION FROM SPACE FOR <2U CUBESATS CONSTELLATIONS.

Abstract

Nowadays there is a general concern for global warming [1, 2] and methane (CH4) is a mayor contributor second only to carbon dioxide (CO2) [3, 4]. Therefore worldwide methane detection and frequent motoring of gas emission sites are of mayor interest. For such purpose, satellite technology has been proven to be one of the most sustainable and cost effective approaches [5, 6], particularly for the case of small satellites like micro/nanosatellites, thanks to their high scalability for fast constellations deployment [7, 8, 9]. In this framework, the most promising methane detection band is the one located at 1.6 m wavelength due to the availability of small, light and low energy consumption detectors [5, 6]. In the SWIR regime, multispectral systems have the advantage over hyperspectral ones to be based on simpler optical architecture, better integrability in small satellites, delivery of 1-2 orders of magnitude lower amount of data, an important advantage considering the well-known bottleneck of limited download band [5,6]. Unfortunately, multispectral systems performance in methane retrieval is worse than the hyperspectral ones especially on heterogeneous surfaces because the first approach doesn't employ any surface reflectance (albedo) correction. Additionally, it is particularly important to measure and disentangle CH4 from water absorption, especially in off-shore measurements [10]. Here we present an original primarily CH4 and secondarily CO2 detection payload, based on an optically simple, compact, light and low energy consumption architecture, which is compatible with integration in a small cubesat of ¡2U size or with a typical microsatellite secondary payload. It is based on a custom multispectral optical filter working in the spectral range 1.6-1.7 m integrated with a commercial lens and InGaAs detector. The filter contains 5 bands of 10 nm fwhm each, best trade-off between fine spectral resolution and robust SNR for a typical micro/nanosatellite capacity. The filter has one band for the CO2 detection and two bands for CH4 detection, they have been chosen to maximize each gas absorption in the SWIR range 1600-1700 nm. Two bands have been spectrally allocated to provide albedo retrieval and humidity level measurement. An original albedo retrieval method has been developed, based on a linear interpolation between the 2 albedo bands, spectrally closely correlated to the CH4 and CO2 bands.

References:
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