Quality Assessment of Data Products from a New-Generation Airborne Imaging Spectrometer

Luciano Alparone[a], Francesco Butera[b], Luca Capobianco[a],
Leandro Chiarantini[b], Sandro Moretti[c], Massimo Selva[a],

a) *Dept. Electronics & Telecoms.,* University of Florence, Via S. Marta, 3, 50139, Florence, Italy
Phone/Fax: (+39 055) 4796563 / 494569; e-mail: alparone@lci.det.unifi.it
b) *Selex Galileo S. p. A.,* Via Einstein, 35, 50015 Campi Bisenzio (Florence), Italy
Phone/Fax: (+39 055) 8950 797 / 619; e-mail: leandro.chiarantini@selexgalileo.com
c) *Dept. Earth Sciences,* University of Florence, Via G. La Pira, 4, 50121, Florence, Italy
Phone/Fax: (+39 055) 2756 246 / 296; e-mail: sandro.moretti@unifi.it

Technological advances in imaging spectrometry have recently motivated the developments of remote sensing instruments having extremely high spectral resolution. The increment in spectral resolution, however, must be accompanied by an equivalent increment in radiometric resolution (i.e., number of radiance levels that can be discriminated in the presence of noise). Otherwise, the practical usefulness expected from the spectrally-enhanced data set may be questionable. The concept of "quality" may be related to the information content, which can be objectively defined, by resorting to Shannon's information theory, from the signal-to-noise ratio (SNR) of the individual bands of the hyperspectral data (1B data products).

This work focuses on an assessment of noise parameters characterizing the hyperspectral images collected by a new-generation high-resolution sensor manufactured by Selex Galileo S.p.A., in Florence, Italy, and named Hyper-SIMGA, which is an imaging spectrometer operating in the push-broom configuration, with 512 bands (2 nm bandwidth) and 256 bands (6 nm bandwidth) in the V-NIR and SWIR wavelengths, respectively.

Noise estimation can be obtained once a suitable parametric model of the noise has been stated. The additive zero-mean noise is split into two terms: the former is independent of the radiance signal and is mainly introduced by the electronics circuitry as a thermal noise. The latter is intrinsically due by the photonic imaging mechanisms (shot noise) and exhibits a variance proportional to the mean of the underlying radiance. The two noise contributions are separately measured by means of an original method, either semi-supervised or fully automatic, relying on selective regressions of local sample statistics ("scatterplot" method). Thanks to the advanced features of the electronic circuitry exploited by the detector, the power of the signal-dependent photonic noise is greater by over two orders of magnitude than the signal-independent thermal/electronics noise. The values obtained automatically by means of the proposed scatterplot method are matched to manual measures on calibration panels, with very good accordance.

Two application scenarios are presented.

1) airborne remote sensing for detection of pollutants and of dangerous materials that appear with low abundance (e.g., asbestos) through linear spectral unmixing;
2) close-range acquisitions of Cultural Heritage historical buildings and artifacts, for noninvasive monitoring of surface weathering (e.g., detecting the presence of gypsum and quantifying its abundance on marble facades).

The task of unmixing the spectra of low-abundance end-members has been seldom pursued by using data from former-generation imaging spectrometers, due to intrinsic limitations in SNR and number of spectral bands, typically 100 – 200 bands and 20 – 25 dB SNR. Thanks to the favorable characteristics of Hyper-SIMGA (512+256=768 spectral bands and average SNR greater than 35 dB), promising preliminary results in both application contexts are presently being achieved.