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Efficient and compact hyperspectral imager for space-borne applications

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In the last decades Hyperspectral Imager (HI) have become irreplaceable space-borne instruments for an increasing number of applications. A number of HIs are now operative onboard (e.g. CHRIS on PROBA), others are going to be launched (e.g. PRISMA, EnMAP, HypSIRI), many others are at the breadboard level. The researchers goal is to realize HI with high spatial and spectral resolution, having low weight and contained dimensions. The most common HI technique is based on the use of a dispersive mean (a grating or a prism) or on the use of band pass filters (tunable or linear variable). These approaches have the advantages of allowing compact devices. Another approach is based on the use of interferometer based spectrometers (Michelson or Sagnac type). The advantage of the latter is a very high efficiency in light collection because of the well-known Felgett and Jaquinot principles.

The HI realized at INRIM is based on a low finesse Fabry-Perot interferometer and combines the advantages of extreme compactness and high efficiency in light collection (being based on the interference principle). The performances of INRIM HI has been demonstrated both in the visible range (400-750 nm) and in the short wave infrared (900-1700 nm) showing medium spectral resolution (4 to 10 nm) and a spatial resolution only limited by the camera [1], [2].

In the present work we demonstrate the superiority of the INRIM device with respect to classical band pass based HI by comparing the results of our device with one based on LCTF (liquid crystal tunable filter). The different Signal to Noise obtained with the same numerical aperture and exposure times are compared. Furthermore comparison with the dimension and weight of comparable performance interferometer based HI is performed [3].

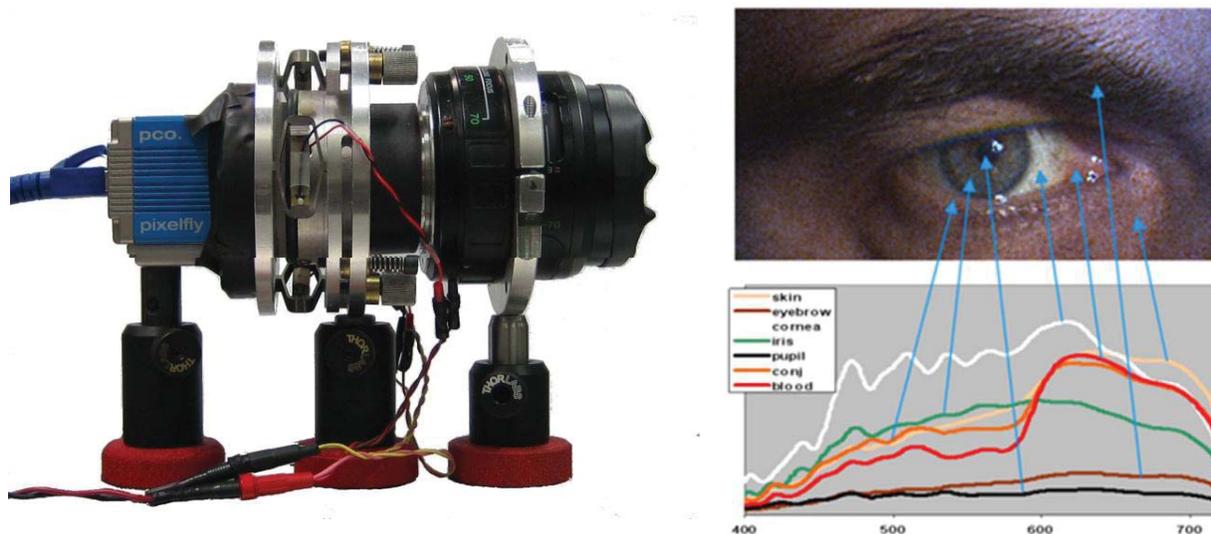


Fig1. Left: the layout of the compact high efficiency INRIM HI made with an objective, a CCD camera and the F-P interferometer; right: an example of high speed hyperspectral imaging obtained with the instrument

[1] M. Pisani and M. Zucco , "Compact imaging spectrometer combining Fourier transform spectroscopy with a Fabry-Perot interferometer", , Optics Express, Vol. 17 Issue 10, pp.8319-8331, (2009)

[2] M. Pisani, P. Bianco and M. Zucco , "Hyperspectral imaging for thermal analysis and remote gas sensing in the short wave", , Applied Physics B: Lasers and Optics, Online First™, DOI: 10.1007/s00340-012-5015-8, (April 2012).

[3] http://www.inrim.it/res/hyperspectral_imaging/