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A new application of hyperspectral radiometry: the characterization of painted surfaces

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Hyperspectral sensors, working in the Visible-Near Infrared and Short Wave Infrared (VNIR-SWIR) regions, are widely employed for geological applications since they can discriminate many inorganic (e.g. mineral phases) and organic compounds (i.e. vegetations and soils) [1]. Their advantage is to work in the portion of the solar spectrum used for remote sensors. Some examples of application of the hyperspectral sensors to the conservation of cultural heritage are also known. These applications concern the detection of gypsum on historical buildings [2], and the monitoring of organic protective materials on stone surfaces [3].
On the contrary, hyperspectral radiometry has not been employed on painted surfaces. Indeed, the characterization of these surfaces is mainly performed with sophisticated, micro-destractive and time-consuming laboratory analyses (i.e. SEM-EDS, FTIR and, GC-MS spectroscopy) or through portable and non-invasive instruments (mid FTIR, micro Raman, XRF, FORS) which work in different spectral ranges [4,5].
In this work the discrimination of many organic and inorganic components from paintings was investigated through a hyperspectral spectroradiometer ,which works in the 350-2500 nm region. The reflectance spectra were collected by the contact reflectance probe, equipped with an internal light source with fixed geometry of illumination and shot.
Several standards samples, selected among the most common materials of paintings, were prepared and analysed in order to collect reference spectra. The standards were prepared with powders of 7 pure pigments, films of 5 varnishes (natural and synthetic), and films of 3 dried binding media. Monochromatic painted surfaces have also been prepared and investigated to verify the identification of different compounds on the surface.
The results show that the discrimination of pure products is possible in the VNIR-SWIR region, except for compounds with similar composition (e.g. natural resins such as dammar and mastic). The reflectance spectra of painted surfaces, as supposed, are more complex than the spectra of pure materials, but the identification of single components is possible if the superficial layer of varnish was thin enough to allow the “penetration” of the irradiation light until the pictorial layer.
Finally, the hyperspectral technique, owe to the fast spectra collection (10 spectra/second) and the friendly use of the instrument, has been proved to be a successful method for the evaluation of cleaning treatments, because of the possibility to monitor the partial or total elimination of varnish.

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