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Monitoring of chemical and physical characteristics of stone surfaces by a portable spectroradiometer

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A portable radiometer (ASD-FieldSpec FP Pro spectroradiometer), which continuously and rapidly acquires punctual reflectance spectra in the 350-2500 nm spectral range, has been recently proposed as non-destructive and non-invasive technology for detecting gypsum and other materials (inorganic as well as organic) on surfaces of historical buildings [1,2,3]. The instrument, which is also capable to quantitatively assess physical changes of the surfaces (i. e. color changes), has the potentialities to be used for monitoring the state of conservation of stone surfaces through the monitoring of the relative abundance of some components considered precursor symptoms of decay. The increase of gypsum or the decrease of the relative abundance of organic materials used as protective materials allows, in fact, to control and detect the chemical attack of carbonate surfaces, as well as the efficacy and durability of protective treatments. Although the relative abundance of any compound is theoretically related to the signal intensities of its spectral signature, a quantitative analysis is often compromised by some factors such as the grain dimension of crystals [2 4]. However the monitoring of critical areas may give useful information on the progression of decay provided that the same areas are investigated.
The spectroradiometer can operate both in natural light conditions and by a contact probe with fixed illumination and geometry of shot; in this study the second condition was preferred since the same operative conditions can be maintained for all the measurements during the monitoring.
Aim of this work was to find an easy to use and accurate system for repositioning the spectroradiometer probe in the same small areas of interest during the long-term monitoring. Two systems (theodolite and distance measuring laser) have been tested and their accuracy has been evaluated on some Florentine historical buildings (Cathedral of Santa Maria del Fiore and Basilica of San Miniato al Monte), selected as case study. Both systems showed good accuracy, within the experimental errors of the spectroradiometer, but the possibility of geo-referencing any small area of the building surface makes the theodolite the better system for monitoring different critical areas of historical stone surfaces.

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