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April 2009 Abruzzo earthquake. Multisensor approach for the seismic rehabilitation of monuments

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The widespread presence of movable and immoveable high cultural value assets make crucial the necessity of their protection, especially in order to mitigate the vulnerability to extreme environmental events, such as the seismic one.
The latter represents the environmental risk factor which affect more than other environmental events the cultural heritage because of the big concentration of monuments and archaeological resources in several seismogenetic areas of the Mediterranean Basin, Middle East, South and Central America.
Protecting monumental heritage, historical centres and archaeological sites from the effects of devastating earthquakes has been the focus of scientific and engineering endeavour for more than 50 years.
Each earthquake not only provides additional information from the seismological point of view but it also stimulates effort to develop new and more advanced operative intervention strategies for the ready protection and restoration of damaged artefacts and structures of cultural value.
Focusing our attention of Italian earthquakes, if the 1993 Umbria and Marche earthquake favoured a re-thinking of some repairing and rehabilitation techniques based on the use of reinforced concrete, the last earthquake occurred in Abruzzo on april 2009 allowed to improve the techniques for ready intervention and the procedures of evaluation of the seismic damage of churches and palaces.
In such context, a significant effort has been undertaken in the experiencing of integrated approaches based on the use of different sensors and methods for the imaging of subsurface geological structures, the characterization of the mechanical behaviour of structures and the analysis of the state of decay of stone materials and frescoes.
This papers deals with the results obtained by means of a multisensor approach performed to support effective and compatible interventions of restoration on a medieval architectural complex near L'Aquila.
In particular, the following diagnostic methods have been used:
i) Electrical Resistivity Tomography (ERT) used for obtaining 2D and 3D high-resolution images of subsurface geological structures; ii) laser scanner survey to obtain a digital model of the monument and to study deformations and collapse mechanisms; iii) infrared thermography for the survey of detachments and cracks on frescoed walls; iv) hyperspectral VNIR imagery for discriminating materials and for detecting moisture, organic content and salinity; v) georadar prospections and sonic tests to survey the inner structure of masonries and to detect cracks and voids; vi) finally, the analysis concerning the fundamental frequency peak of the foundation soil derived from microtremor data, which allowed to obtain insights about possible soil-structure resonance by comparing the dynamic features of the soil with the main building frequency.