



## **An integrated approach of non-destructive tests for inspection and characterization of cultural heritage: case study of Monastery of Batalha, Portugal**

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The built heritage under the ambient conditions, even with a proper maintenance, can have pathologies and defects due to deterioration of materials, repeated loads and exceptional events. It is widely recognized that new technologies can play an important role in documentation, interpretation, diagnosis, monitoring and preservation of our cultural heritage legacy. The complexity of these innovative systems continues to increase and 3D digital construction and documentation of built heritage remains a complex issue. The methodologies typically involves a hybrid approach to the visualization of heterogeneous datasets such as multispectral images, geophysics data, thermographic images and 3D imaging data (laser scanning, photogrammetry). Thus an integrated approach to understand and support heritage documentation and preservation of ancient historical environments is demanded.

In this paper the authors present a method that merge a set of non-destructive tests performed using terrestrial laser scanning, infrared thermography, ground penetrating radar (GPR) and multispectral images. The method was applied in the inspection and characterization of the Monastery of Santa Maria da Vitória, also known as the Monastery of Batalha. The historical Monastery of Batalha is one of the most beautiful and important examples of Portuguese and European architecture, composed by several styles, namely Gothic, Manuelino and some renaissance details, being part of the UNESCO World Heritage List since December 1983.

A framework based on integrate innovative techniques was applied in order to obtain high-fidelity 3D models from existing heritage, allowing to record and analyze relevant spatial 3D data. Ground-penetrating radar (GPR) is also proposed as a solution to characterize and document structural damages and other pathologies as well as to provide information regarding the internal structure and building technics of the monument.

Methodologies for data acquisition are also analyzed giving emphasis to relevant limitations and solutions to optimize the surveys. Finally, a discussion is presented considering the complementarities and synergies between the different techniques according to the challenges presented in this case study.

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