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GPR surveys as element of a sustainable management process of urban cities: the case of Matera (Italy), the European Capital of Culture in 2019

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Vulnerability of urban areas and their infrastructures depends on many different factors (e.g. ageing of structures, differential displacements, presence of dangerous factors in the underground) and is now worsened by the effects of climate changes. Therefore, the necessity of performing long-term assessment is mandatory and the challenging aim is to "monitor" cities and embedded infrastructures, by accounting for multiplicity of possible risks/hazards.
In this context, there is the necessity to investigate underground that is not only a possible cause of hazard but can also be considered a factor of social and economic growth due to buried archaeological assets, which if properly exploited, can become a factor improving the social identity of the community and enable touristic opportunities. Moreover, underground structures may represent an obstacle to urban redevelopment and qualification activities, because their preservation entails stringent constraints about planning and execution of engineering works.
We discuss about effectiveness of Ground Penetrating Radar (GPR) surveys for underground inspections at the Matera city (Italy), a significant example of the necessity of underground management and monitoring [1].
Matera is the European Capital of Culture in 2019 and is characterized by an underground very rich in terms of presence of environmental features as cavities, voids and pre-existing cultural assets [1]. Specifically, we present results of GPR surveys carried out at two important squares of Matera, i.e. "Piazza San Rocco" and "Piazza Duomo". These squares are important for the presence in the same area of cavities, tanks and archaeological remains.
In this frame, interpretability of GPR surveys is rather challenging and advanced data processing are needed [2]. We exploited a microwave tomography (MT) based data processing chain. MT states the GPR imaging as an electromagnetic inverse problem, where one aims at achieving detection, localization and geometry estimation of a hidden target starting from the electromagnetic field backscattered by the target [3].
Effectiveness of GPR surveys is also enhanced by using the novel IDS Stream-X GPR. This system has 16 antennas working at 200MHz and is able to collect at the same time 15 B-scans, along profiles 12 cm equally spaced. Accordingly, a data pre-processing strategy specifically built for Stream-X system was developed. This data processing strategy is organized in three steps: a) pre-processing in time domain; b) application of MT to the pre-processed data, in order to achieve 2D tomographic reconstructions; c) pseudo 3D representation, where 2D tomographic images are merged in a cube representing the investigated areas and then the results are presented as constant-depth slices. GPR survey results were decisive for the characterization, in terms of location and geometry, of buried targets that are a "mix" of man-made and environmental structures.

References

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