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Integration of InSAR and GPR techniques for transport network monitoring purposes

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Monitoring the evolution of surface and structural deformations in linear transport networks, such as highways and railways, caused by natural events or human-related activities is a crucial task to maintain the highest operational safety standards.

To that effect, interferometric synthetic aperture radar (InSAR) has been extensively acknowledged as a viable methodology for the investigation of surface deformations at the network level. However, potential of this method for transport infrastructure monitoring has not been thoroughly explored yet.

Conversely, ground-penetrating radar (GPR) has gained momentum across the spectrum of available non-destructive testing methods. This is mainly due to the high flexibility of use with respect to specific survey conditions, the high productivity and a well-recognised capability to detect physical discontinuities of the subsurface. Nevertheless, use of calibration cores is generally required to achieve reliable results in GPR surveys, as different and complex causes could produce similar results in terms of data outputs (e.g., similar radargrams).

In view of the above, an integrated use of InSAR and GPR methods for monitoring purposes of linear infrastructures might allow i) to identify deformation spots at the network level and ii) to understand potential sources of damage for the identified decay area. To this effect, it is also important to emphasize the viability of combining the above two stages on the definition of a priority-based maintenance plan.

In this study, a demonstration of the combined use of InSAR and GPR methods for monitoring a railway track has been given. The main objective was to provide a viable methodology capable to identify potential decay areas (InSAR) and investigate the causes of damage (GPR).

To this purpose, the permanent scatterers InSAR (PS-InSAR) technique was applied to identify ground displacements occurred over a railway track located in Puglia, Southern Italy. At the same time, field tests with GPR were carried out using multi-frequency systems equipped with horn antennas and mounted on an inspection convoy.

Useful insights have been pointed out and relevant critical areas of possible weaknesses in the railway track have been detected. Results have demonstrated the viability of integrating InSAR and GPR methods, paving the way to future implementations of automatic algorithms for the effective assessment of safety-critical conditions of linear infrastructures.