Geophysical Research Abstracts
Vol. 16, EGU2014-10914, 2014
EGU General Assembly 2014

An integrated sensing technique for smart monitoring of water pipelines

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Lowering the rate of water leakage from the network of underground pipes is one of the requirements that "smart" cities have to comply with. In fact, losses in the water supply infrastructure have a remarkable social, environmental and economic impact, which obviously conflicts with the expected efficiency and sustainability of a smart city. As a consequence, there is a huge interest in developing prevention policies based on state-of-art sensing techniques and possibly their integration, as well as in envisaging ad hoc technical solutions designed for the application at hand.
As a contribution to this framework, in this communication we present an approach aimed to pursue a thorough non-invasive monitoring of water pipelines, with both high spatial and temporal resolution. This goal is necessary to guarantee that maintenance operations are performed timely, so to reduce the extent of the leakage and its possible side effects, and precisely, so to minimize the cost and the discomfort resulting from operating on the water supply network.
The proposed approach integrates two sensing techniques that work at different spatial and temporal scales. The first one is meant to provide a continuous (in both space and time) monitoring of the pipeline and exploits a distributed optic fiber sensor based on the Brillouin scattering phenomenon. This technique provides the "low" spatial resolution information (at meter scale) needed to reveal the presence of a leak and call for interventions [1]. The second technique is based on the use of Ground Penetrating Radar (GPR) and is meant to provide detailed images of area where the damage has been detected. GPR systems equipped with suitable data processing strategies [2,3] are indeed capable of providing images of the shallow underground, where the pipes would be buried, characterized by a spatial resolution in the order of a few centimeters. This capability is crucial to address in the most proper way maintenance operations, by for instance reducing as much as possible the extent of the area where excavations have to undergo or suggesting a suitable timing for the interventions.

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