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Parametric pipe detection on the urban site Sense-City using GPR

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Sense-City facility is a modeled urban test-bed of 250 m2 (25m×10m) located at University Paris-Est (France) that is dedicated to the validation of measurement technologies in the field of urban sustainability [1]. The novel Ground-Penetrating Radar (GPR) test site falls within the purview of Sense-City smart road topic, as networks usually lie below road structures. This site lies within the actual concern of mapping the underground with a non-destructive technique to retrieve the location of underground pipelines, in order to update urban cadastral databases, to contribute to space saving and to a wise use of land resources when planning for new networks. Thus, the test site designed provides several sources of measurement interest expressed by the presence of a multilayered soil with significant dielectric contrasts, and two distinct areas dedicated to the validation of utility mapping tools, one with buried pipes, and the other with buried blades with various dielectric properties; the objects having a relative small lateral dimension (less than 15 cm) have been buried at several depths (ranging from 14.5 to 64.5 cm) in trenches filled with a backfill soil different from the natural soil.
This paper is focused on the buried pipe area: experimental radargrams have been acquired using several GPR systems (GSSI SIR 3000, UtilityScan DF and a SFCW made of a pair of bowtie slot antennas conceived in our laboratory) operating at frequencies ranging from 300 MHz to 1.5 GHz. At first, the comparison and the interpretation of a few raw Bscans have allowed to characterize the dielectric properties of the soil layers. Afterwards, during the experiments made with the different GPR systems, we have studied the hyperbola signatures of the buried pipes according to several parameters such as central frequency, dielectric contrast of the objects (air filled or water filled), and polarization. The results of this study will help to further evaluate and develop different types of algorithms in signal and image processing (wavelet transform, Hilbert transform, matched filter, mode decomposition, super resolution algorithm, template matching, migration…) in radargrams to finally extract quantitative information. Experimental results highlight that 800 and 900 MHz are the most suited frequencies to obtain radargrams with enough resolution and penetration to characterize the buried objects with relatively small lateral dimension. First measurements have been made in the blade zone and they are currently under interpretation.
[1] http://www.sense-city.univ-paris-est.fr/index.php