Adaptive Mapping Routes of Pipes in Water Supply Systems using GPR and Multi-agent Approach

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Abstract

This paper proposes the multi-agent paradigm as an approach to generate mapping routes of pipes in water supply systems (WSS) from data obtained by non-destructive methods. The relevance of this work hinges on the fact that records of components, layouts, and other characteristics in most WSS companies exhibit great inaccuracy or even are inexistent in many cases. To cope with this situation, street surveys are usually undertaken through road excavation for management's reasons. The economic and social impact of this form of exploration is sometimes unaffordable. As a consequence, growing interest for non-destructive methods in explorations of WSS components, instead of other destructive testing methods, is currently observed. However, with the complexity of the spatial layouts of the networks, along with the steady growth of the cities, and hence the WSS infrastructure, and the huge volume of generated information with non-destructive methods, the difficulty of data analysis is increased.

The aim of this work is twofold: 1) evaluate the collected data and redefine, on-site, the mapping routes for data capturing, in the case it has not been taken previously, and 2) evaluate the collected data, and generate efficient analyses of data routes. The detection of pipes and other components in WSS seeks both objectives. To achieve these objectives, we use the ground penetrating radar (GPR) as a non-destructive method [1]. The proposed architecture for mapping routes is based on an iterative analysis process based on a multi-agent system. This procedure is performed by agents endowed with a knowledge engine that simulates a stochastic process that propose different pseudo-random walks [2] aimed at studying the features provided for the GPR data. In this way, the areas with lower probability of existence of pipes are disregarded by the agents. This procedure is applied iteratively for integration into a process that produces aggregate survey GPR routes, and that eventually shape the map of location of buried WSS pipes. The purpose of this work improves the usual exhaustive scanning systems with GPR, thereby the survey time is optimized and the amount of data needed to conduct records of the components of the WSS is minimized.

Keywords: Ground penetrating radar; signal processing; adaptive mapping routes; multi-agent systems; stochastic processes.

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