Towards the visualization of water supply system components with GPR images

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**ABSTRACT**

We propose a methodological tool for examining the layout and revealing the concealed characteristics of urban water supply systems (WSS). For this purpose, we use underground images obtained with ground penetrating radar (GPR) as a method that does not alter the system conditions and environmental characteristics (non-destructive methods). The study focuses on wave amplitude and uses intensive matrix manipulation. We obtain promising results as the methodology, which is non-subjective and repeatable, visualizes buried pipes with efficiency. This tool will help WSS managers obtain a more accurate picture of WSS and so offer a better service to users.

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1. Introduction

Water supply systems (WSS) are mainly composed of pipes, valves, reservoirs, and other ancillary elements. Knowledge of these components and any changes suffered are necessary to control and productively manage the system. The aims of this approach include: detecting illegal connections; estimating lost water volumes; simulating system scenarios; studying pollutant evolution in the network; and examining rehabilitation strategies.

This work proposes a first step towards developing a tool for identifying unknown component characteristics in urban WSS. It is based on the use of ground penetrating radar (GPR) as a non-invasive technique enabling buried objects to be detected without altering the environment. GPR technology development started in 1904, and there have been many studies made regarding GPR prospection [1]. Many efforts have sought to improve GPR interpretation and obtain faster image identification.

The methodologies applied in object recognition using GPR images are associated with the following tasks: (1) object detection and location; (2) object material recognition; (3) object size estimation; (4) object shape estimation [2]. There have been interesting works on GPR detection in landmine searching [3], archaeological exploration [4], and steel reinforcement in concrete [5], among others. In WSS, various procedures have been adapted from other prospection image interpretation methods. The aim is to obtain clean images for locating objects. Olhoeft [6] used a GPR image of a buried metal pipe to explain background removal, as well as gradient filter and migration procedures. Thus, an image was clarified to determine the location of a pipe, and define its depth and size. Liu and Shen [7] also carried out a numerical simulation using methodologies such as the transmission-line-matrix (TLM) and employing Maxwell’s equations to identify metal pipes. Similar works were performed by Tavera [8], using Hilbert and Fourier transforms to detect water leakage features and patterns from GPR images of WSS. As computer technology has improved, there have been increased efforts to develop tools based on intelligent systems.

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