Water Supply System Component Evaluation from GPR Radargrams using a Multi-agent Approach

D. Ayala-Cabrera[a], J. Izquierdo[a], I. Montalvo [a], R. Pérez-García[a]
[a]IMM - Universidad Politécnica de Valencia,
C. de Vera s/n, Edif 5C, 46022 Valencia, Spain

Abstract

The multi-agent paradigm [1] is used in this paper to assess components of water supply systems (WSS) from GPR radargrams. The aim of this work is to provide non-highly qualified technicians with non-destructive, easy and quick procedures of interpretation of GPR images. These procedures will enable them to gain insight into the sometimes unknown layouts of the systems, and to unveil various concealed characteristics of the components of WSS. Following the same line of research on GPR image processing started in a previous work by the authors [2], this paper takes the matter further by presenting a new multi-agent algorithm. The *agent racing* algorithm has been developed in Matlab and is based on Game Theory. The input is the result of the survey GPR radargram, which is a matrix of size $m \times n$. The n traces generated by the GPR survey are used as pseudo-parallel tracks for the n agents to compete. The racing is based on a property that we call agents' *stamina*, and comprises two phases: a) warming-up, and b) racing. The phases are characterized by two time values: a warming-up time (t_w) and a racing time (t_r), totaling a time $t = t_w + t_r$ that equals m, the length of each trace. The movement of agents during the racing will be conditioned by the changing trends of the traces they travel through. The racing will end once elapsed time t, and the winner is the agent having experienced more movement during the race.

The output is a matrix of size $m_1 \times n$; where m_1 = maximum number of agents' movements. The columns of this matrix, describing the agents' movements, together with the associated racing times can be interpreted in an interesting way. In effect, this analysis enables easy determination of the electromagnetic properties of the prospected underground and provides an accurate classification of underground properties. The results of this agent racing algorithm are promising, since it groups and, consequently, decreases the amount of points that make up the initial radargrams, while at the same time preserves its main properties and promotes clearer views of pipes and better identification of the components in WSS.

Keywords: Ground penetrating radar; signal processing; image processing and analysis; multi-agent systems; agent race.

[1] Ayala-Cabrera, D., Herrera, M., Montalvo, I., Pérez-García, R. (2011). Towards the visualization of water supply system components with GPR images. Mathematical and Computer Modelling. In press.

[2] Shoham, J. & Leyton-Brown, K. (2008). Multiagent systems: algorithmic, game-theoretic and logical foundations. Cambridge University Press.