# Evaluation of effectiveness of ground penetrating radar exploration method using polarization characteristics by model experiment and numerical simulation

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Ground penetrating radar (GPR), one of geophysical exploration methods, is used for buried objects, geological, and resource surveys. For the data processing, common offset Common Midpoint (CMP) methods are used generally by only information on the arrival times of reflected waves. Therefore, it is still difficult to accurately clarify underground structure and physical prosperities. In order to solve this problem, use of information on the magnitude and waveform of the reflected waves is expected to be effective in addition to the travel time information. Thus, this study aims to develop a method with multiple antenna directions to obtain more underground information. In the general measurement method, the direction of the antenna is fixed, which produces only one polarization component of the electromagnetic wave. In this study, we set two antenna directions for wide angle measurement. By comparing the data obtained from a model experiment with the simulation results, effectiveness of the ground penetrating radar using the polarization characteristics and also, validity of the simulation method are examined.

First, we conducted a small-scale experiment of ground penetrating radar exploration in a tank filled with silica sand. Groundwater table can be changed in this tank. The water table was divided into five stages for the wide angle measurement. The measured antenna directions were set perpendicular and parallel to the side line. Next, we performed an electromagnetic wave propagation simulation in order to quantitatively determine the change in radar waveform caused by the water table and antenna direction using a three-dimensional Finite Difference Time Domain (FDTD) method, which is known as the main method of electromagnetic field analysis and fast calculation. As a result of comparing the experimental with the simulation results, the magnitude of the reflected wave and the time of arrival of the reflected wave were found to be agreeable with each other. The waveform also changed greatly, suggesting that differences in reflection characteristics due to the antenna direction as well as the radar spacing appeared. Using this difference, we plan to determine physical properties such as dielectric constant.

 