

Applicability of Phased Array Antenna for Ground Penetrating Radar for Subsurface Imaging

*Kaito Kikuchi¹, Hitoshi Mikada¹, Junichi Takekawa¹

1. Graduate School of Engineering, Kyoto University

Ground Penetrating Radar (GPR) has become important for detecting natural and artificial burial materials in the subsurface. However, there is a problem in the current practice of GPR surveys. In the field experiment, it is difficult to obtain subsurface images beneath surface structures such as buildings or trees. We would like to propose the utilization of a phased array antenna as a radar source. In our study, we take a GPR system as an example to emphasize the importance of the phased array system. We use a 3-D FDTD method to examine how efficiently our radar system works. Firstly, we describe the theory of numerical method and our strategy of controlling the direction of electromagnetic waves. Next, we compare a dipole antenna and the phased array antenna to evaluate the efficiency of the phased array system in the shallow subsurface. Finally, we move the phased array antenna along the survey line assuming actual GPR surveys. We applied a 3-D Kirchhoff migration method to estimate the position of anomalies in the subsurface. In addition, we use all the antenna units as transmitters and receivers in order to obtain higher resolution. Our result shows that the phased array antenna has an advantage in enhancing the signal-to-noise ratio and enhancing the amplitude of scattered waves from the reflectors located lateral to the survey line. This indicates the possibility to probe the subsurface even below obstacle that prevents the surveys on the surface. We conclude that our phased array system has a potential to be used as an angular scanner imaging tool that has not yet been attempted in the conventional GPR system. This GPR system may reduce the number of survey lines and lower the cost of GPR surveys.

Keywords: Ground Penetrating Radar, Phased Array Antenna, Geophysics