## Development of Phased Array Ground Penetrating Radar for near surface exploration

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A portable and non-destructive geophysical tool, Ground Penetrating Radar (GPR), enables us to quickly detect the objects in the shallow subsurface such as cavity, electric cables or water pipes. It is increasingly applied for preventing near surface hazards. Although the resolution of GPR under the antenna is generally very high, the resolution out of the survey lines is depending on the shape of the antenna. We have recently introduced a phased array antenna as a new radar source to overcome this problem (Kikuchi et al., 2016). We showed that comparing with the conventional dipole antenna, the phased array antenna increased the signal-to-noise ratio in observed data resulting from heterogeneity of subsurface and it improved the migration results for the reflectors located lateral to the survey line. However, the coupling effect between array antennas on generated waveform was not taken into consideration. In this study, we calculate the mutual impedance to evaluate the mutual coupling of the array to determine the suitable antenna arrangement. Then, we conducted some GPR surveys in more practical conditions. We use a FDTD method to simulate the propagation of electromagnetic (EM) wave field. Kirchhoff migration method is used to make a 3-D image of subsurface. Our results show that the phased array antenna provides more reliable migration results compared to the dipole antenna we have designed. We conclude that our developed new GPR has an advantage in detecting objects between the survey lines or under the surface structures where we cannot draw a survey line. This will surely lead to the reduction of the cost of GPR surveys.

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