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Development and Fundamental Experiments for Validation of Transmission-type Ground Penetrating Radar

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Visualization techniques of the subsurface structure using the electromagnetic waves have been used widely in many fields such as detecting underground pipe, investigation of existence of underground space and underground crack that can cause subsidence, excavation of archeological site, estimating geologic structure, and natural resource exploration. To improve the accuracy of visualization, estimation of subsurface physical properties such as dielectricity electric conductivity, and magnetic permeability is indispensable, which can contribute to identify the subsurface materials in addition to geometrical properties of material boundaries. However, it is difficult to estimate such subsurface properties at the present because of strong heterogeneity concerning physical properties distribution and shape of stratum boundary.

For this problem, we developed a prototype system of Ground Penetrating Radar (GPR) which separates transmission antenna and receiving antenna. A merit of this transmission-type GPR (T-GPR) is that the input signal can be received at the antenna more strongly than the traditional reflection-type GPR by reducing travel distance of radar by half.

Capability of the T-GPR was tested by a problem that it could detect caves in the ground under the water table. Simple ground model was produced using soils, water, and two types of pipes (vinyl chloride tube and Hume pipe) which were buried under the cave. These pipes were a model of actual drain pipe. Transmission antenna and receiving antenna were set on the surface and in the pipes, respectively. As the result, our T-GPR could detect the cave in the soils saturated with water regardless of the type of the pipes, which demonstrates the usefulness of T-GPR consequently.

Keywords: Ground Penetrating Radar, transmission, cave detection, drain pipe, saturated soil with groundwater