Automatic estimation of the position of buried pipes based on the spatial distribution of semblance

*Kunio Aoike[1], Takanori Ogahara[1], Kazunori Takahashi[1]

1. Oyo corporation

In recent years, Building Information Modeling (BIM) has been expected to be adopted for efficient maintaining and managing social infrastructure such as buried objects laid complexly in the underground of cities. Although the buried objects had so far been managed by the simple database of the facilitie administrators, the issue was that the locations were not accurate even though the existences and the types of buried objects were known. Therefore, it is important for BIM to reconstruct 3-D model of the buried objects by surveying the precise locations. It also demands to realize with low cost. To solve these problems, we developed simple 3-D analysis method for the buried pipes using semblance. We applied the method to the data which was acquired using our test sites for detection of the buried objects. We report the results in the study.
A hyperbolic curve appears on the B-scan image drawn by scanning to the transverse direction against a buried pipe. Since symmetric and continuous patterns are characteristic of the buried pipes and rare in the natural underground, the reflected wave from the buried pipe is easy to identify. The engineering geophysicists have so far mapped the position of buried pipes using this property. Here, if we regard the observed hyperbolic curve as the time curve traveled from a single point reflector, we can obtain the propagation velocity so that the semblance calculated along the travel time curve is maximized. We call the propagation velocity the apparent velocity. We conducted highly dense GPR survey at our test sites and analyzed the buried pipes. The survey lines were placed not only the longitudinal direction but the transversal direction. Using the data, we searched the semblance as the values maximize while changing the apparent velocity and extracted the local maximum values from the spatial semblance distribution. Although the obtained point clouds of the semblance contained not only reflections from buried pipes but also the other scatters in the soils, the points by buried pipes tended to show higher semblance. The results of simulating the travel time curve in case of the survey line located orthogonal to the direction of cylindrical pipe in subsurface showed almost equivalent to a point reflection, however when closing the crossing angle between the survey line and the cylindrical pipe down to 45 degree, the apparent velocity was up to about 1.5 times of actual velocity. We tried to filter for passing only the point clouds of the buried pipes. Using the constraints of the simulated apparent velocity range, we searched the cloud which the number of the counts aligned on the line connected between a pair of high semblance points is maximum. And we removed the isolated points. Consequently, we could automatically extract the point clouds of buried pipes (Fig. 1).
In next tasks, we have a plan to cluster the filtered point clouds to each buried pipe group and insert the objects correspond to specification of the pipe. We are developing the automatic method of the clustering. We think that the estimated depth errors of the reconstructed 3-D model will be improve because the propagation velocities will be more accurate by considering the crossing angle between the survey line and the buried pipe.

Keywords: ground penetrating radar, 3D geophysics, buried pipe

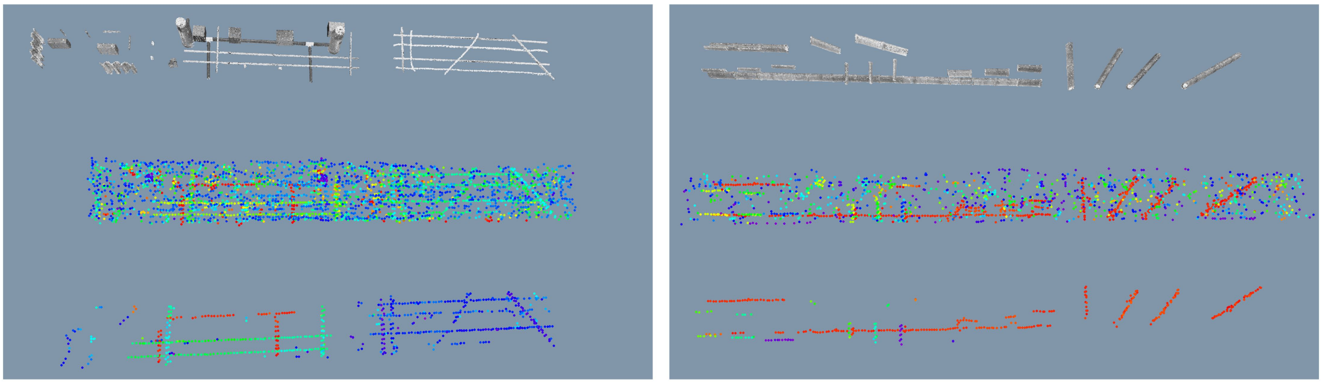

Fig. 1 The comparison between the laser–scanned buried objects and the analyzed semblance points in two test sites. The left panel shows the results of Site1 installed various buried objects and the right panel shows the results of Site3 buried Hume pipes. The upper gray scaled point clouds show the laser–scanned data and the middle colored point clouds are the searched semblance points and the lower colored point clouds are the filtered point clouds. The warm colors show relative deeper position and the cold colors show relative shallow position.