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Inversion Approaches in Cross-Hole Borehole Radar

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Tomography technique will be one of the most popular imaging scheme using cross-hole geophysical measurement. In the analysis of cross-hole borehole radar, velocity and attenuation tomography have been normally used, however, due to limited data acquisition capability, in some cases, we cannot get satisfactory results.

We have interested in alternative imaging approaches to tomography which can be applied to cross-hole borehole radar data sets. And we proposed a few new approaches [1][2].

If the host rock is relatively resistive, electromagnetic attenuation is small and signal processing techniques used in seismic signal processing are quite useful for borehole radar. We tested migration approach to the cross-hole borehole radar,. Which we acquired for cavity detection. The borehole separation is 20m and the depth of the cavity is more than 70m. In this relatively large scale, we could image the air-filled-cavity by migration approach.

However, if the host material is lossy, such as soil, migration algorithm Is not effective. If the shape of the target is known, although the exact size and shape is unknown we can adopt a simplified inversion algorithm for estimation of the location of the target. This is a parametric inversion approach. We tested this technique for accurate location estimation of a metallic pipe buried in wet soil. From the cross hole borehole radar data, we can find only slight change of the arrival time of the direct wave, however, by the inversion algorithm, we found that we can estimate the pipe location very accurately. The same algorithm was tested for the detection of cavity, which we described in the previous section. Even in large scale measurement, the parametric inversion

scheme is very effective, and the location of the air-filled cavity could be determined very accurately.

1. Subsurface Cavity Imaging by Crosshole Borehole Radar Measurements. [IEEE Trans. Geoscience and Remote Sensing, 42 (2), (2004), 335-341], Hui Zhou, Motoyuki Sato

2. Kazunori Takahashi, Motoyuki Sato [2006], Parametric Inversion Technique for Location of Cylindrical Structures by Cross-Hole Measurements, IEEE Transactions on Geoscience and Remote Sensing, Vol.44, no.11, pp.3348-3355.