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Imaging of Underground Targets with an Improved Back-Projection Algorithm

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Abstract : Ground Penetrating Radar (GPR) is an important nondestructive remote sensing tool that has been used in both military and civilian fields. Recently, GPR imaging has attracted lots of attention in detection of subsurface shallow small targets such as landmines and unexploded ordnance and also imaging behind the wall for security applications. For the monostatic arrangement in the space-time GPR image, a single point target appears as a hyperbolic curve because of the different trip times of the EM wave when the radar moves along a synthetic aperture and collects reflectivity of the subsurface targets. With this hyperbolic curve, the resolution along the synthetic aperture direction shows undesired low resolution features owing to the tails of hyperbola. However, highly accurate information about the size, electromagnetic (EM) reflectivity, and depth of the buried objects is essential in most GPR applications. Therefore hyperbolic curve behavior in the space-time GPR image is often willing to be transformed to a focused pattern showing the object's true location and size together with its EM scattering. The common goal in a typical GPR image is to display the information of the spatial location and the reflectivity of an underground object. Therefore, the main challenge of GPR imaging technique is to devise an image reconstruction algorithm that provides high resolution and good suppression of strong artifacts and noise. In this paper, at first, the standard back-projection (BP) algorithm that was adapted to GPR imaging applications used for the image reconstruction. The standard BP algorithm was limited with against strong noise and a lot of artifacts, which have adverse effects on the following work like detection targets. Thus, an improved BP is based on cross-correlation between the receiving signals proposed for decreasing noises and suppression artifacts. To improve the quality of the results of proposed BP imaging algorithm, a weight factor was designed for each point in region imaging. Compared to a standard BP algorithm scheme, the improved algorithm produces images of higher quality and resolution. This proposed improved BP algorithm was applied on the simulation and the real GPR data and the results showed that the proposed improved BP imaging algorithm has a superior suppression artifacts and produces images with high quality and resolution. In order to quantitatively describe the imaging results on the effect of artifact suppression, focusing parameter was evaluated.

Keywords : algorithm, back-projection, GPR, remote sensing
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