

A Robust and Fast Imaging Algorithm with an Envelope of Circles for UWB Pulse Radars

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Introduction UWB pulse radar systems have a high potential for a high-resolution imaging in indoor environments. We have already proposed a fast imaging algorithm called SEABED based on a reversible transform BST(Boundary Scattering Transform) between the received signals and the target shape. However, the image obtained by SEABED deteriorates in a noisy environment because it utilizes a derivative of received data. In this paper, we propose a robust imaging method with an envelope of circles.

Proposed Algorithm We utilize a mono-static radar system. We assume a convex target which has a clear boundary. We define (x, y) as a point in the real space. An omni-directional antenna is scanned along x axis. X is the x coordinates of the antenna location, and Y is the range, which can be measured by UWB radars, as shown in Fig. 1. The curve (X, Y) is called a quasi wavefront. SEABED estimates the target image with a reversible transform BST between the target boundary and the quasi wavefront. However, the image of the SEABED deteriorates in a noisy environment because it utilizes dY/dX in the BST. To solve this problem, we propose a robust imaging method with an envelop of circles. In this method, we plot a circle $(x - X)^2 + y^2 = Y^2$ for each (X, Y) as shown in Fig. 2. We have proven that an envelope of these circles corresponds to the target boundary. By utilizing this relationship, we estimate the target boundary as an envelope of circles. This method transforms the group of points (X, Y) to the group of points (x, y) without the derivative dY/dX . Therefore it can achieve a stable imaging even in a noisy environment.

Performance Evaluation Fig. 1 and 2 show the estimated points with SEABED and the proposed method, respectively. Here we set the sampling number to 101, and S/N to 6.0 dB. We confirm that the estimated image of SEABED deteriorates, and cannot reconstruct the outline of the target boundary due to the noise. On the contrary, the image obtained by the proposed method is stable and precise. This is because the proposed method does not spoil the information of the inclination of image. The calculation time of this method is within 0.2 sec for Xeon 3.2 GHz processor, which is short enough for realtime operations.

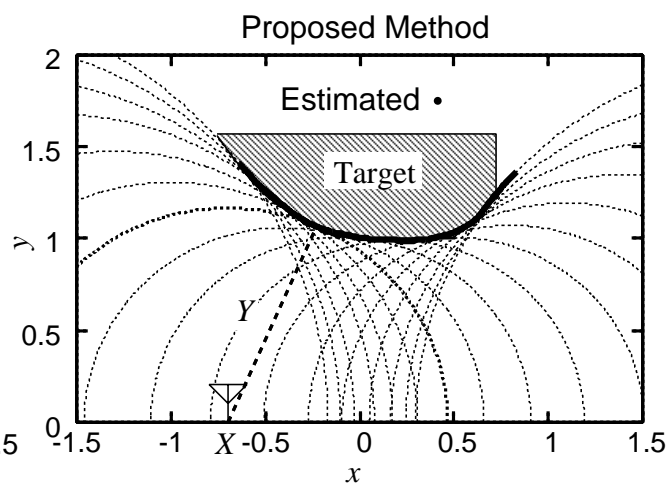
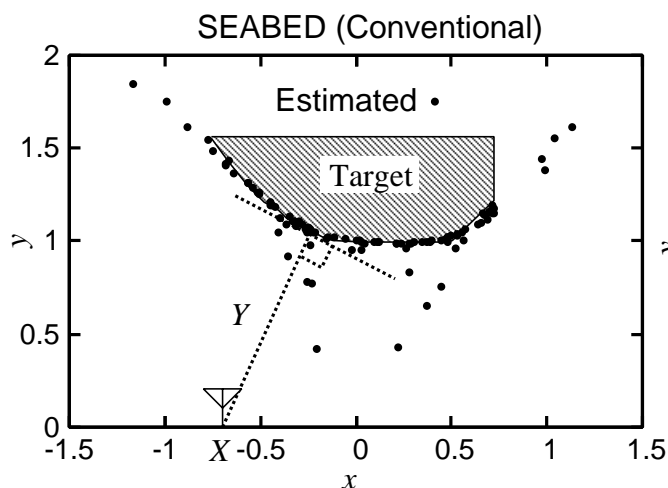


Figure 1: Estimated image with SEABED.

Figure 2: Estimated image with the proposed method.