Small Calcification Detector for Ultrasonography Using Decorrelation of Echo Caused by Calcification

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1. Introduction

Ultrasonography (US) has an excellent ability to depict soft tissue without ionizing radiation; however, the detectability of US for small calcification is insufficient compared with CT and other X-ray tests. As a result, US often plays a secondary role when making a distinction between malignant and benign masses. For the improvement of US in calcification detection we have proposed a novel method to detect small calcifications in ultrasound B-mode images using decorrelation of echoes. In this study we experimentally evaluate the potential of the proposed method for the improvement in calcification detection of US.

2. Materials and Methods

The waveform of a transmit pulse changes at a calcification position, resulting the echo waveform of a scan line with a calcification quite different from that without a calcification. Using this waveform characteristic the proposed method predicts the existence of a calcification from the waveform difference between adjacent echoes. To evaluate the proposed method we prepared a calcification phantom, where three copper wires 0.2, 0.29, and 0.4 mm in diameter were embedded in the phantom at 3 cm depth and a polyethylene sheet 0.1 mm thick was put close behind the wires. We applied the method to raw ultrasound in-phase and quadrature (IQ) data of the calcification phantom measured by a commercial ultrasonographic device (EUB-8500; Hitachi Co. LTD.).

3. Results

Fig. 1 shows the difficulty to detect the wire targets from a conventional B-mode image. The proposed method estimates wire positions correctly, as shown in Fig. 2. 11 of 15 wire targets 0.2-0.4 mm in diameter were detected, yielding a sensitivity of 73.3% and a specificity of 100%, where upon clinical inspection these targets were hardly detected in ultrasound B-mode images. This study indicates the potential of the proposed method to decrease the detectable calcification size using US devices by more than one order of magnitude.

Key Words—Ultrasonography, Calcification, Calcification detector, Correlation

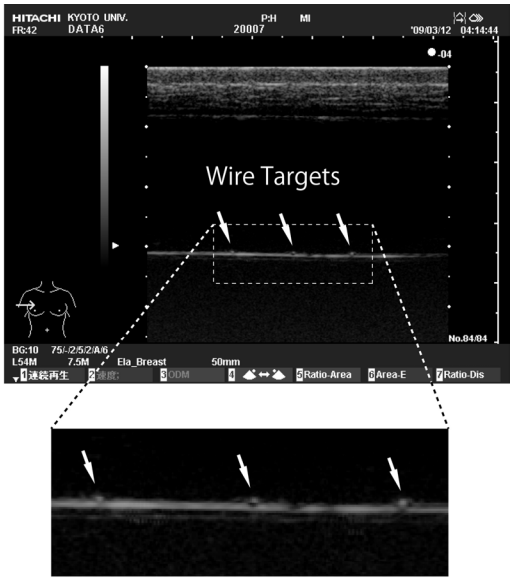

Fig 1. B-mode image of a calcification phantom.

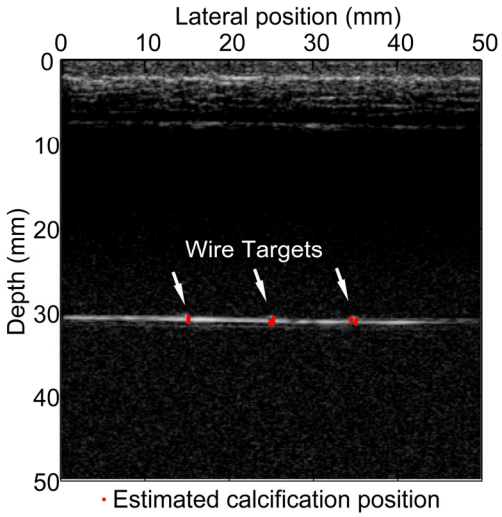

Fig. 2. Estimated wire target positions selected by the proposed method.