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Ultrasound Computed Tomography for orthopedic application

超音波 CT の整形外科応用の検討

Takashi Azuma†[1,2], Xiaolei Qu[2] ([1]Grad. School Med., The Univ. of Tokyo, [2]Grad. School Eng., The Univ. of Tokyo)
東　隆†[1,2], 屈暁磊[2]　([1]東大　医, [2]東大　工)

1. Introduction

Currently, echo imaging is widely used as a medical imaging method due to its portability, low cost and spatiotemporal resolution. Another tomography method using ultrasound, USCT (Ultrasound Computed Tomography) acquires reflected wave as well as transmitted wave, which can reconstruct the profile of medium sound speed. Greenleaf *et al.*[1] showed that sound speed and attenuation index could be used to distinguish benign masses from cancer by measuring the sound property in a breast. However, this method was not used as populer clinical imaging method due to the limited performance of CPU in those days.

Duric *et al.*[2] developed the Computed Ultrasound Risk Evaluation (CURE) for the whole breast imaging system with high performance computing system. In this system, sound speed and attenuation profile in the breast is main target for diagnosis of breast cancer.

On the other hand, the ring array transducer and ring synthetic aperture echo imaging[3] as shown in Fig.1 was suitable for a shadow-less scatter imaging. From this point of view, the combination method of the ring array transducer and ring synthetic aperture imaging has a possibility for imaging of orthopedic applications. In this paper, preliminary trails to orthopedic applications using ring array was described.

2. Method

A ring transducer array with a center frequency of 1.6 MHz was composed of 8 concave transducer arrays, having 200 mm of inner diameter. Each of the concave transducer array has 256 elements with the inner-element pitch of 0.325 mm. The experimental set up was composed of the ring transducer array, a multiplexer, the Verasonics ultrasound imaging system (Verasonics, Inc. WA, USA), and a workstation. For one emission, four neighbor elements emitted in the same time as a point source for keeping sufficient signal-to-noise ratio (SNR). For the whole scanning, 256 point sources in the ring transducer with the same interval were employed. For receiving, the 2048 elements of the ring transducer array were connected to the Verasonics system with 256 channels by using the multiplexer, then the data was send to the workstation. A synthetic aperture imaging method as shown in Fig. 1 was applied to obtain cross-sectional images of human leg and heal.

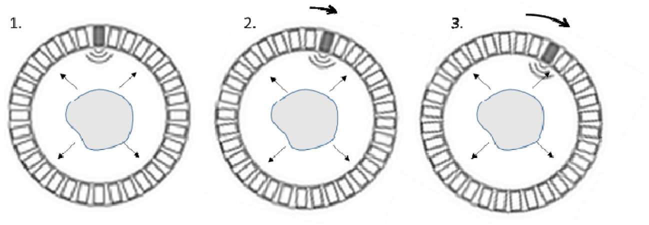

Fig.1 Imaging sequence of "Ring synthetic aperture imaging"

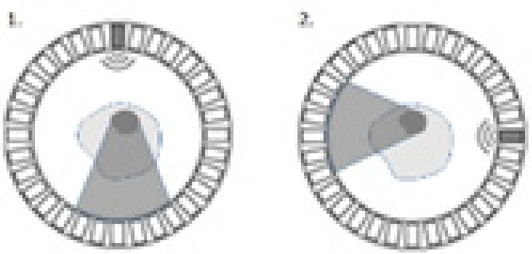

Fig.2 Shadow-less imaging using ring array and ring synthetic aperture imaging

3. Results

Figure 3(a) and 3(b) show cross-sectional images of leg and heal, respectively. In these images, we can successfully suppress shadow effects in these images based on the combination method of ring array transducer and ring synthetic aperture imaging. In these images, inside of bone could not be imaged. However, information of soft tissue structure surrounding or connecting the bone are important in the field of orthopedic area. Both images of leg and heal have many potentials in these applications.

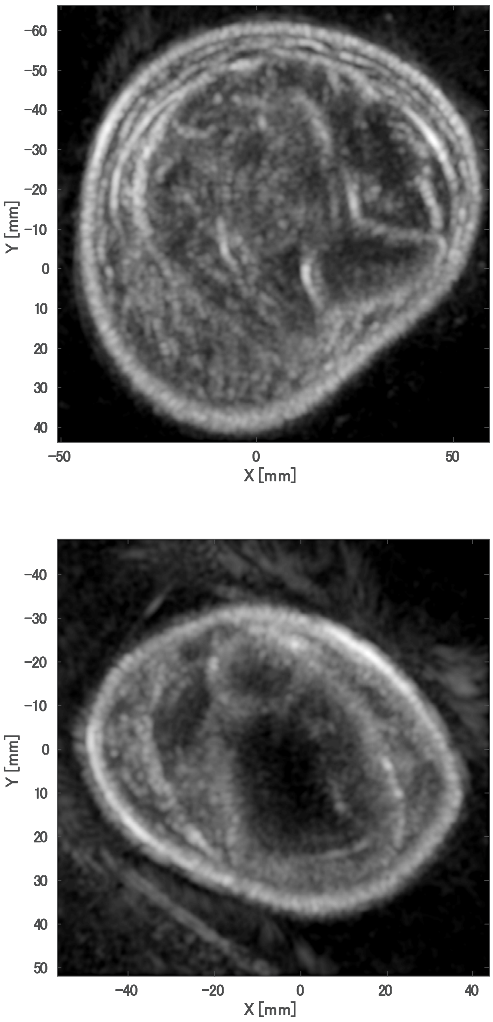

Fig.3 (a): crosssectional image of leg and crosssectional image of heal

4. Summary

In this paper, the combination method of the ring array transducer and ring synthetic aperture imaging was used for imaging of leg and heal cross-sections. The shadow-less images was very imformative about soft tissue surrounding bone and showed potential usefulness in the orthopedic application.

References

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