2P5-3

Simultaneous Multimodality imaging of MR and ultrasound

MRと超音波の同時マルチモダリティイメージング

Shimpei Arai[1†], Shoko Kato[1], Ken Inagaki[1], Iwaki Akiyama[1] ([1] Faculty of Life and Medical Sciences, Doshisha Univ.)
新井　慎平[1†], 加藤　聖子[1], 稲垣　拳[1], 秋山　いわき[1] ([1]同志社大学　生命医科学研究科)

1. Introduction

Recentry, ultrasound and MR multimodality imaging has been active in the field of clinical diagnosis. The purpose of this study is the development of a simultaneous multimodality imaging system and to show the feasibility of this technique. One of the significant issue for this technique is development of the probe available for simultaneous use of MRI. Thus the prototype probe consist of non-magnetic materials was developped. Another significant issue is to estimate a cross section of ultrasonic image in the three dimensional image of MRI. MR visible fiducial markers were developped and attached with the probe to estimate the cross section. Concequently, the feasibility of the simultaneous multimodality imaging system is discussed by phantom and human neck imaging in this study.

2. Methods and materials

2.1 Prototype probe

The non-magnetic probe with MR visible fiducial marker is shown in Fig.1. The specification of the prototype probe is listed as Table 1. The transducer is made of 1-3 piezo-composite material. The marker is a made of a POM sphere with a diameter of 6.35 mm immersed in plant oil placed in an cylindrical acrylic container with a diameter of 8.0 mm and a height of 9.5 mm. The markers are arranged in two rows as shown in Fig.1. The transducer array are fixed along the center line among the two maker arrays.

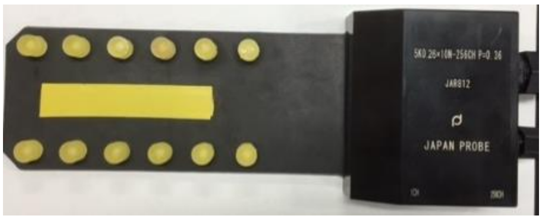

Fig.1 The prototype array probe attached with MR visible fiducial markers. The specification of the probe is listed in Table 1.

iakiyama@mail.doshisha.ac.jp

Table 1 Specification of the prototype probe.

Elements	TX/RX channels	Element Pitch	Acoustic lens focal length
192	128	0.30 mm	20 mm

2.2 Experiment

1.5T MRI (Echelon Vega, Hitachi co., Japan) was used in the experiments. An ultrasonic imaging system (RSYS0006 MRFP, Microsonic co., Japan) was installed in the operation room of MRI system. To reduce the electrical cross talk noises, the ultrasonic imaging equipment is connected by the prototype probe through a connector on the separation wall between the MRI room and the operation room, since the conector was grounded through the wall. The probe was available to use in the gantry. Simultaneous imaging of an agar-gel phantom and a healthy volunteer's neck was carried out in the experiments by using ultrasound and MR. The experimental system is shown in Fig.2. It is required for synthesizing two images into single image to estimate the cross section of ultrasonic image in 3 dimensional image of MRI. The size of the agar phantom is 100mm cube, and it contains a conical type phantom with the longest diameter of 40 mm and a height of 40 mm and a cuboid shape phantom of length, width, height of 40 mm, 40mm, 70 mm. It contains graphite powder as scatterers. Accuracy of mesured values was discussed separately for a lateral, range, and elevational direction.

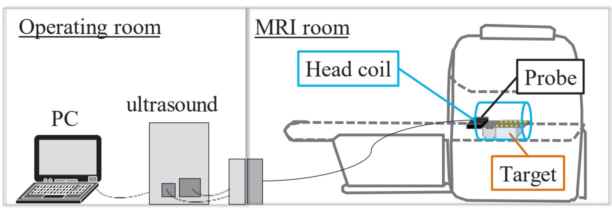

Fig.2 Experimental system of US and MR simultaneous multimodality imaging.

3. Result and discussion

The ultrasonic and MR image of the phantom are shown in Fig.3. The cross section of ultrasonic image was estimated in the 3 dimensional image agreed the actual section within 4 mm error. The value of difference is caused by sound velocity difference between the actual value and the estimated value. The ultrasonic and MR images for the human neck are shown in Fig.4 and Fig.5, respectively. An artifact due to multiple reflection was found in the trachea portion in the ultrasonic image as shown in Fig.4. To reduce the artifacts in the trachea portion, a binarization of MRI were carried out as shown in Fig.6. After that, binarized image was multiplied by the ultrasonic image.

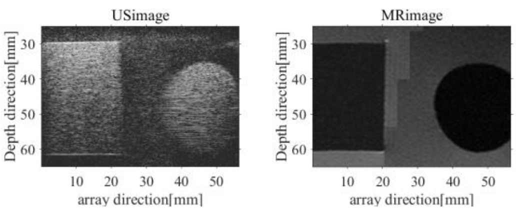

Fig.3 Ultrasonic image (left) and MR image (right) of the phantom.

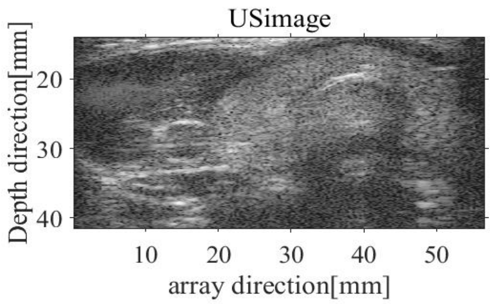

Fig.4 Ultrasonic image of the human neck.

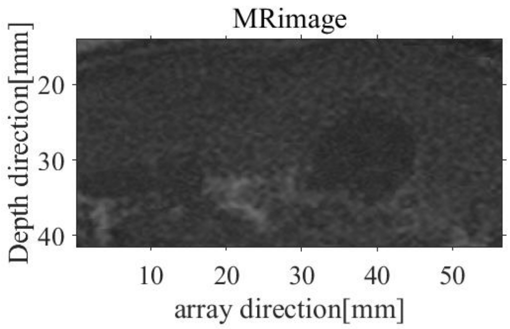

Fig.5 MR image of the human neck.

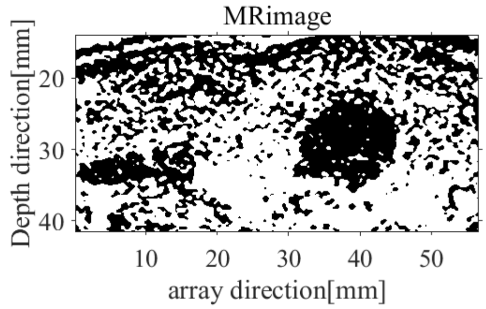

Fig.6 Binarized image of MRI of the neck.

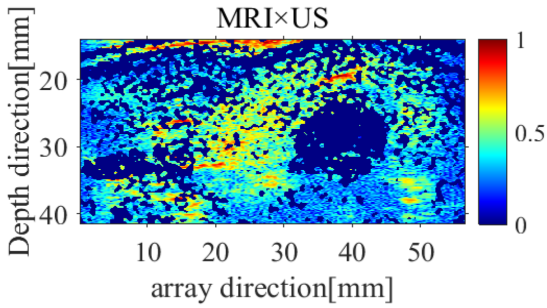

Fig.7 Synthesized image of US and MR.

As a result of the reduction of artifacts, the region of thyroid is emphasized as a green region in the synthesized image as shown in Fig.7.

4. Conclusion

In this study, US and MR simultaneous multimodality imaging system was developed. Then feasibility of the proposed method was studied by using the prototype system. It is shown that the synthesized image emphasize the thyroid region due to the reduction of the artifacts from US image.

Acknowledgment

This study was supported by MEXT-Supported Program for the Strategic Research Foundation at Private Universities. The authors wish to thank Mr. Kazuya Niyagawa with Ricoh co ltd. for his contribution to fiducial processing.

References

1. M. Nejati, H. Pourghassem, J Med Syst, Vol.38, pp.1-10 (2014)
2. L. Marksa, S. Younga, S. Natarajan “MRI–ultrasound fusion for guidance of targeted prostate biopsy”, Curr Opin Urol.,Vol.23(1), pp.43-50 (2013)