US and MR Multimodality Imaging of The Heart

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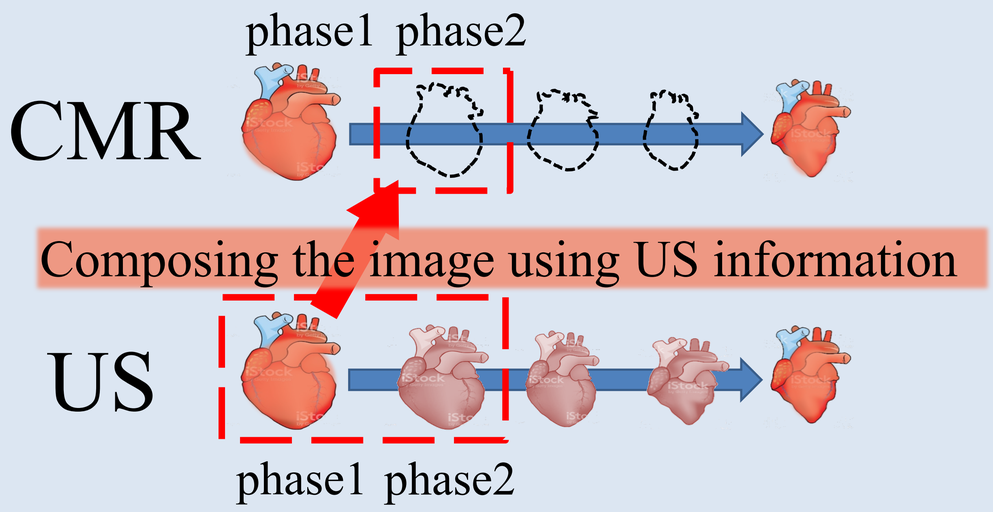
Introduction

Multimodality imaging system

A multimodality imaging system of simultaneous ultrasound and MR has a potential to provide the feasible information for the clinical diagnosis.

Purpose

US and MR image registration using mutual information and compositing the MR image using US movement information of the heart.

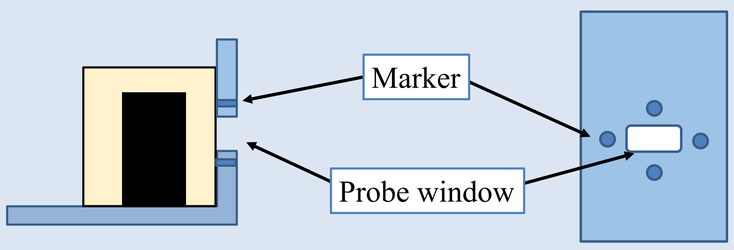


High resolution composite image of US and MRI

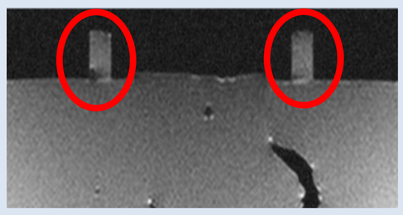
- We propose multi-modality imaging system to create high resolution composite images by MRI and real time imaging ultrasonic diagnostic equipment.

Experimental method

- MRI (Hitachi Echelon Vega, 1.5 T) and ultrasonic imaging system (Prosound α 7, Hitachi) was used.



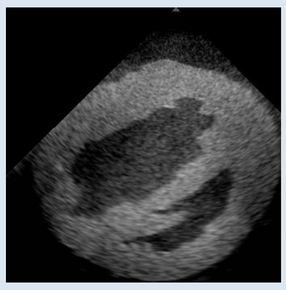
Side view



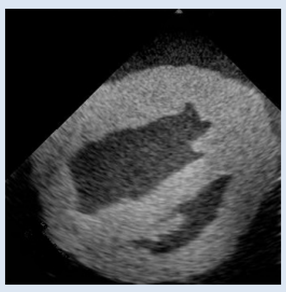
Front view

Marker shown on MR image

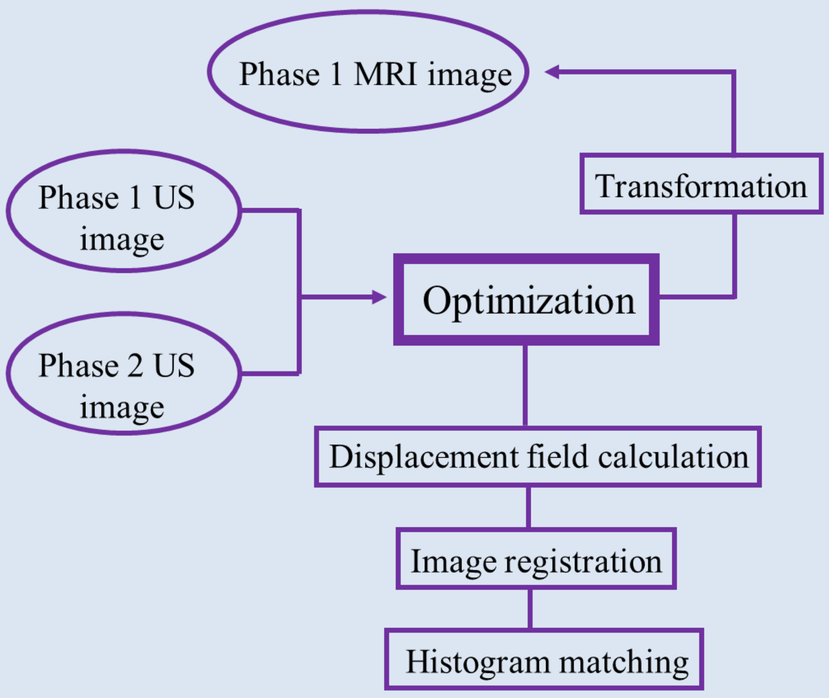
- The same cross section as the ultrasonic image was detected by MRI image using a 7 mm diameter marker shown above.
- Displacement field was calculated from the 2 phases of the US image to apply for phase1 MR image to composite phase2 MR image.



Phase1 US image



Phase2 US image



Tissue mimicking phantom of the heart

- The model for each phases of the heart was 3D printed from an actual video of an human heart taken at 60 fps.

3D printed model

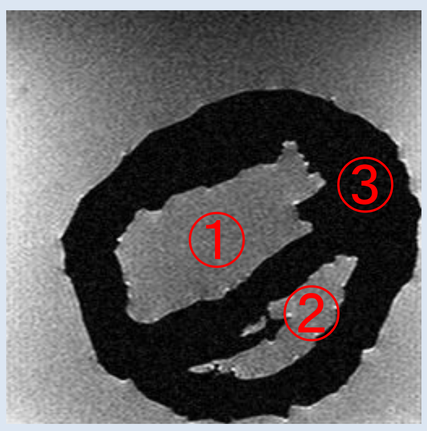
Phase1 phantom

MR image

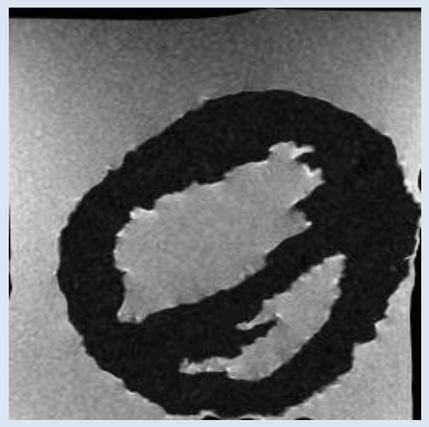
Phantom material
Heart shaped inclusion : Agar 30%, graphite 5%, ethanol 7%
Surrounding phantom : Agar 30%

Result and Discussion

- Displacement field calculated from the 2 phases of the US image was applied the MR image.



Phase2 MRI image



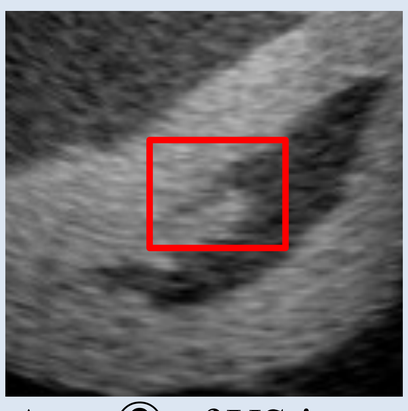
Composed phase2 MRI image

- The NCC value for the entire image was 0.88. The NCC value for each section is shown in the table below.

	NCC value
Area ①	0.93
Area ②	0.82
Area ③	0.93

NCC value of each section

Phase2 US image



Area ② of US image

- The NCC value for the area ② was low compared to the other section of the image. One possible cause is that the contrast of the US image was low due to the speckle noise.

The program was not able to calculate the displacement field properly.

Conclusion

- We were able to determine the displacement field from the US image and apply it to the MRI image. For the future work image process improvement is required of US image.