Multi-perspective 2D Ultrafast Ultrasound and Strain Imaging

Peilu Liu, Marloes Sjoerdsma, Hein de Hoop, Frans van de Vosse, Richard Lopata
Eindhoven University of Technology, Eindhoven, Netherlands

Background, Motivation and Objective

Ultrasound (US) imaging is an important diagnostic tool due to its ease of use, low cost, portability and non-invasiveness. US, however, does have several shortcomings because of physical constraints – limited field-of-view, resolution, and contrast anisotropy – that cannot be resolved when using a single probe. In this study, we introduce a novel multi-perspective 2D ultrafast ultrasound imaging system, aiming at imaging the left ventricle of the heart, acquiring ultrasound data from two separate probes simultaneously to enlarge field-of-view and improve image contrast and strain imaging.

Statement of Contribution/Methods

In a vitro experiment of a beating porcine heart (PhysioHeart, LifeTec, NL), we acquired parasternal long axis and apical views of the left ventricle with two phased array probes (P4-2V, Verasonics). The probes were attached to a fixation device in which the relative position could be adjusted. Data were acquired at a frame rate of 160 FPS using spherical wave imaging under 7 angles (Fig. 1). After the acquisition, image registration algorithms were developed to automatically align the US images from two different probes. Image fusion was performed subsequently by taking the left ventricular walls of the two image datasets in the overlapping regions. First- and second-order speckle statistics were computed to analyze the probability distribution function and point spread function of the multi-probe imaging system. Next, strain imaging of the left ventricular wall was applied to assess the benefits of multi-probe imaging. Segmentation of the left ventricular wall was performed manually at the beginning of motion tracking. Different displacement compounding methods (averaging, compounding, weighted compounding) were implemented. Finally, compounded and uncompounded radial and longitudinal strain were calculated and compared.

Results/Discussion

An example of a fused image is shown in Fig. 1D. Histogram analysis of the gray values shows that the probability distribution function of the fused images is more narrow and centered. Similarly, autocorrelation results show that the point-spread function of the imaging system has become isotropic. The mean error of the tracking displacement decreased by 24.2% after weighted compounding. The standard deviation of longitudinal and radial strains reduced by 16.2% and 15.4% respectively.

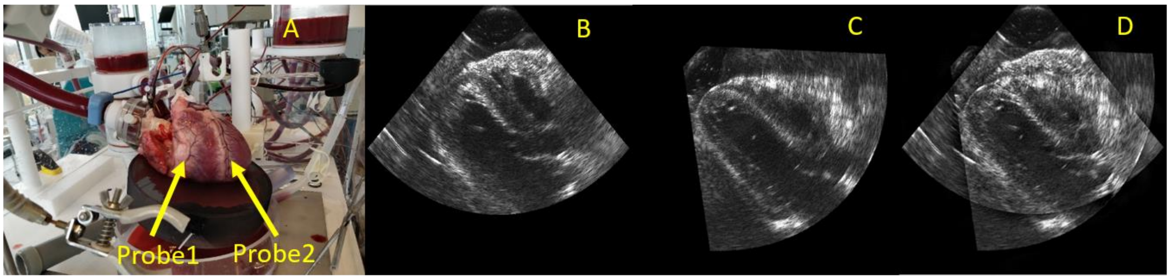

Fig. 1 : A) PhysioHeart experiment and dual probe setup ; B) Image obtained by probe 1 ; C) Image obtained with probe 2 at a relative angle of 48°; D) Post registration fused image.