Simultaneous Reconstruction of Respiratory and Cardiac Motion from Cine Magnetic Resonance Imaging

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Popular Science Description

Heart disease is currently the leading cause of death in the world, which killed nearly 17 million people in 2011 [1]. For this reason, research in heart disease is of the up-most importance, particularly for the Western World. Due to the continuing development of computing and medical imaging, new ways of approaching heart research are emerging. Through the use of Magnetic Resonance Imaging (MRI), the heart can be assessed in a non-invasive way.

The Lund University Cardiac MR Group use MRI technology to develop a better understanding of how the heart functions. By using MRI techniques new aspects of pumping motion of the heart in live patients can be seen. This will assist clinical physiologists in their understanding of the heart.

In this thesis, real-time Cardiac Magnetic Resonance Imaging (heart MRI) data is used to create reconstructed heart beats for multiple phases of the breathing cycle.

The motivation for this thesis is that, in physiology, previous studies have shown that breathing affects the heart pumping but currently details are unknown. Further to this, current techniques of scanning the heart with MRI have their limitations. The patient must breath out and hold their breath while being scanned so the breathing motion doesn't blur the images. This makes scanning difficult for some patients.

The central idea towards resolving these problems is to use real-time heart MRI. By doing so the patient can breath freely and reconstructed heart beats can be created for each phase of the breathing cycle. Below is an example of the real-time heart MRI data, Figure 1.

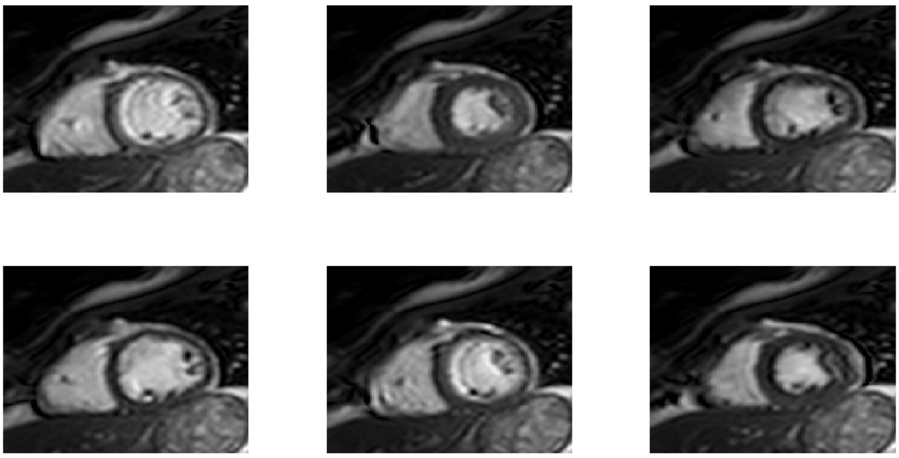

Figure 1: Example of real-time heart MRI data

The advantage of real-time imaging is that a physiologist will have a useful tool to further understand changes in the heart due to breathing motion. Another advantage is that the method has the potential to obtain heart MRI data in a more comfortable way as the patient

[1] World Health Organisation, `http://www.who.int/mediacentre/factsheets/fs310/en/`, July 2013.

would be allowed to breath freely whilst being scanned.

In order to achieve the goal, computers were used to analyse all images in the real-time heart MRI data. Thus it can be determined for each image, where in the breathing cycle it was and where in the heart beat cycle it was. Now that each of the images have been labelled with their positions in the breathing cycle and heart beat cycle, the computer can then take the relevant images and recreate heart beats at different stages of the breathing cycle. Below is an example of one of the recreated heart beats for one stage of the breathing cycle, Figure 2.

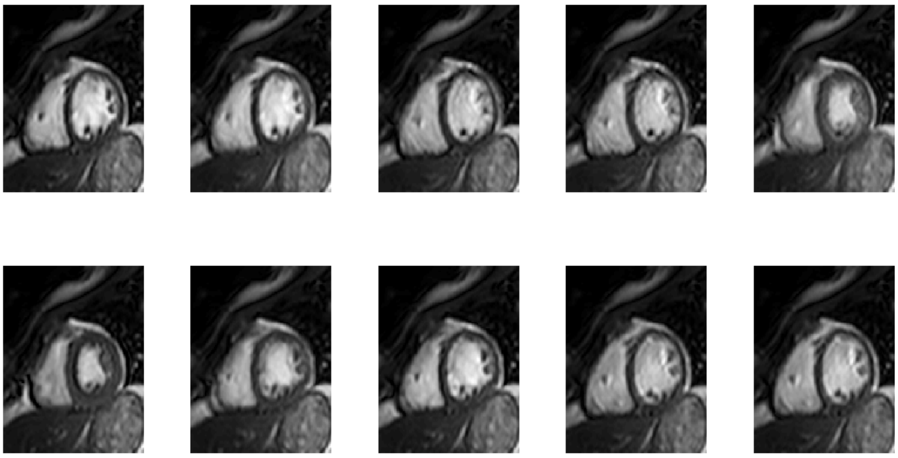

Figure 2: Recreated heart beat for one stage of the breathing cycle.

Overall the aim of this thesis was achieved. The method created used real-time heart MRI data and was able to accurately present heart beats at multiple breathing phases. The method labelled each of the images accurately which produced viable reconstructed heart beats. The information presented from this method gives a deeper insight into the motion of the heart and gives a tool to be used by physiologists.

An area for improvement would be the time for the computer to calculate the reconstructed heart beats. Currently it would take around 50 minutes to reconstruct the heart beats so exploring alternative methods to speed up the calculations would be advantageous.

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