

Retrospective Respiratory Compensation for Cardiac MRI

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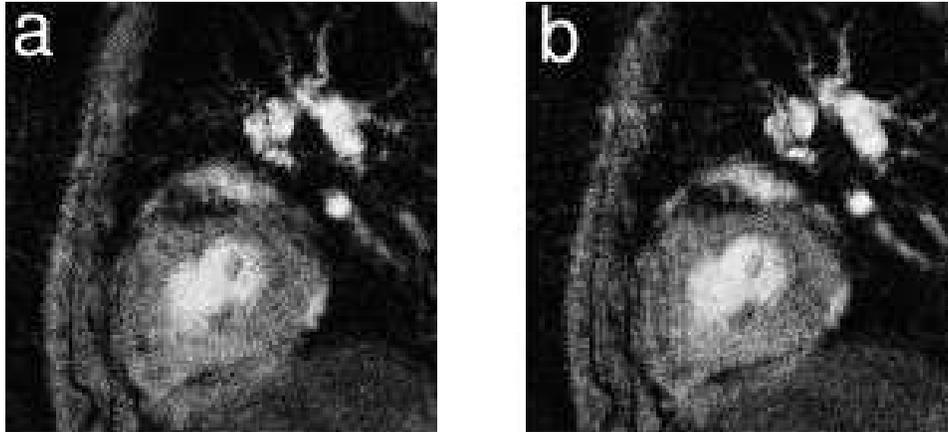
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1 Introduction

Cardiac MRI is known to be degraded by respiratory motion. Short scans can be performed using breath-hold techniques, while coronary artery imaging commonly use navigator gated sequences, acquiring data in a known static respiration position. Phase reordering reduces respiration artifacts without prolonging the scan, but may still leave some artifacts. Automatic motion compensation based on an image quality metric has previously been suggested [1,2]. In our approach we use a motion model and the respiratory bellow signal recorded during the scan to optimize the image quality. The parameters of a quadratic transfer function (from the bellow signal to the actual displacement) are optimized until a maximum image quality is obtained.

2 Methods

In-vivo data were acquired on a 1.5 T scanner (GE Medical Systems, Milwaukee, WI). A sagittal 2D slice with frequency encoding in the SI direction was acquired using a gradient echo pulse sequence with the following parameters: matrix=256x256, FOV=32cm, slice thickness=7mm, flip angle=20°, TE=6.4ms, TR=20ms. Each k-space line was repeated 64 times, giving a total scan time of 5.28 minutes. Cardiac and respiratory information was collected simultaneously using a pulse oximeter and a respiration bellow. This information was then used for retrospective cardiac cine reconstruction to 64 time-frames using nearest neighbor interpolation. Pure translational motion in both in-plane directions was assumed, and a second-order polynomial transfer function from the respiratory data



(obtained using the respiratory bellow) to translation in pixels was applied. A resulting image was reconstructed by adding a linear phase shift to the k-space lines, followed by regular IFFT. The parameters for the transfer function were obtained by gradient descent optimization using a local gradient entropy quality metric.

3 Results

In-vivo data were obtained by scanning a 26 year old male volunteer, instructed to breathe normally during the experiment. A systolic time-frame was studied. The resulting images are shown below. The left image (a) shows the original image. The right image (b) shows the result after reconstructing the modified k-space. Improved delineation of the epi- and endocardium can be seen, and better demarcation of the peripheral pulmonary vessels.

4 Discussion

The method only compensates for in-plane motion in the 2D case, but extension to 3D will enable motion compensation in all directions. This might be useful for 3D flow acquisitions and high resolution morphological scans, such as coronary artery imaging.

References

1. Atkinson D. et al., [1997] IEEE Trans.Med.Imag. 16(6):903-910
2. McGee KP. et al., [1997] Radiology 205:541-545