Advantages of Channel by Channel Artifact Detection and Correction

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Introduction

Multi-channel coils are widely used in clinical practice. Due to coil geometry, these channels have spatially different sensitivity to signal, as well as to artifacts caused by local motion or hardware imperfections. A coil element at a greater distance to a moving organ has lower sensitivity to the motion than a coil element which is closer. Therefore it may be advantageous to perform detection and correction for each channel individually for artifacts due to local motion or hardware imperfections, as opposed to strategies on composite signal for bulk motion. Experiments using in-vivo data with artifacts due to different reasons, show the advantages of channel-by-channel artifact reduction over conventional methods using composite signal: lower residual artifact level and/or higher signal to noise ratio (SNR).

Theory

Conventional artifact detection and compensation techniques, such as navigators [1,2] and data consistency based methods [3-5], treat all channels equally and usually use the composite signal (combination of all channels) to detect artifacts. This strategy is suitable if all coil elements have similar level of sensitivity to the artifacts, such as the artifacts due to bulk motion. Because elements of a multi-channel coil have spatially different sensitivity to signal due to the coil geometry, many sources of artifacts impact the data acquired by different coil elements in different ways and to different extents [6]. The difference in sensitivity to artifacts suggests that the distribution of corrupted *k*-space data is different from channel to channel. Therefore, the locations of the corrupted *k*-space data should be detected for each channel individually. Navigator based methods, which have navigators acquired by all coil elements, can be used to detect motion channel wise. The data convolution and combination operation (COCOA) [5] algorithm generates synthetic *k*-space data for each coil element and can also be used to detect motion for each individual channel.

Method

One set of spine data (T2w TSE) acquired on a Philips 1.5 T Achieva system with a 16-channel C-spine coil was used to explain the proposed method and show the performance of the method for swallowing. Three sets of shoulder images acquired using a 4-channel shoulder coil on a 3T Philips Achieva system were used to demonstrate the performance of the proposed method for artifacts due to pulsation (PDw TSE and STIR TSE), and breathing (T1w TSE) respectively. As a specific example, COCOA was used to detect and correct the motion polluted data. Synthetic *k*-space data were generated for each channel by convolution in *k*-space. The synthetic and the original *k*-space data sets were compared channel by channel for the locations of motion polluted data for each channel individually. The motion polluted data were substituted by the synthetic *k*-space data.

Result

Figs 1-4 compare the channel-by-channel COCOA to conventional COCOA which treats all channels equally. Fig. 1 shows that the rejection of two channels with high inconsistency level further reduced the artifact level due to swallowing with insignificant impact to the SNR in the region of interest. In all three examples for shoulder imaging, the proposed method resulted in lower residual artifact level. Figure 3 shows the result of the proposed method also has higher SNR than the result of conventional COCOA.

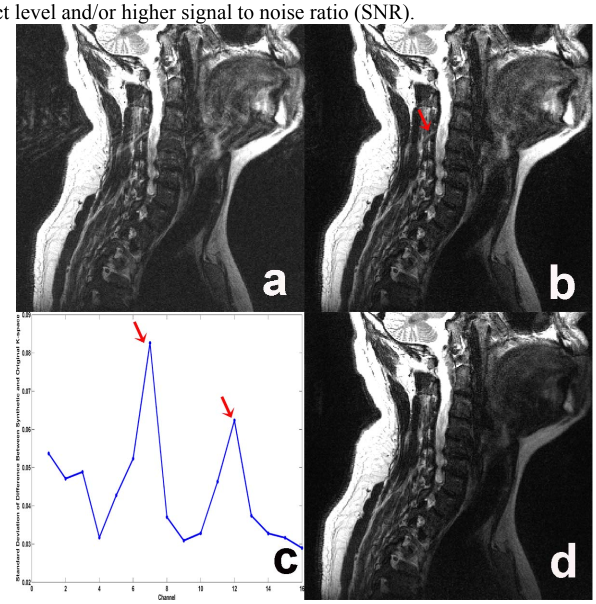
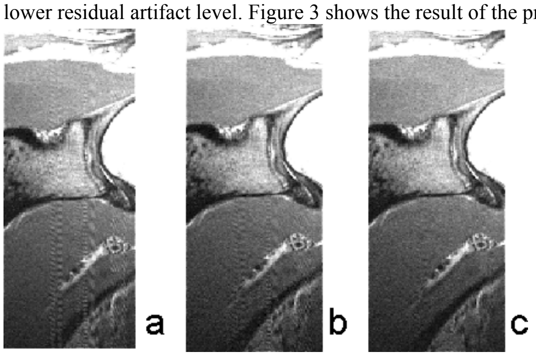
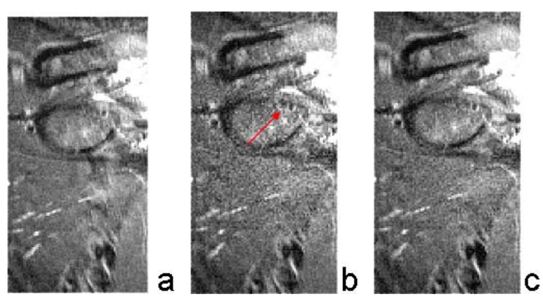
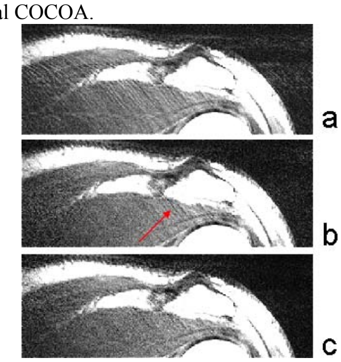


Figure 1. Spine data set scanned with 16ch RF-coil. a) and b) are reconstructions before and after conventional COCOA. The red arrow shows the residual artifacts. c) the data inconsistency of each channel. X-axis is the count of channel. The red arrows show that channels 7 and 12 have high level of inconsistency. d) COCOA reconstruction without using channels 7 and 12.







Figures 2, 3, and 4: From left to right, these images are Figures 2, 3, and 4 respectively. Only zoomed in images are shown for better visibility. a) image before artifact reduction. b) result of conventional COCOA. c) result of channel by channel COCOA. The red arrows show the locations of residual artifacts.

Discussions and Conclusion:

As shown by Fig. 1c, different channels have different levels of sensitivity to the artifacts. Treating all channels equally in motion detection may reduce the sensitivity to motions which only impact one channel, and result in residual artifacts. If data regeneration, instead of data reacquisition, is used for data compensation, treating all channels equally could result in lower SNR or residual artifacts because of discarding data from coil elements insensitive to the moving structures, and is not polluted by motion. The proposed method is different from the idea in coil-based artifact reduction [6] which uses the coil sensitivity to detect the artifacts in image space, but does not detect and correct the artifact for each channel individually. In conclusion, it was shown that the use of channel wise detection and correction strategy for artifacts due to spike and/or non-bulk motions can achieve higher SNR and/or lower residual artifact level.

References :

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