

## FULLY-AUTOMATED COIL CHANNEL SELECTION IN CARDIAC MRI

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**INTRODUCTION:** High numbers of receive coils dramatically increase the data volume of an MRI scan. This hampers data storage, handling and transportation and prolongs post-processing times, e.g. for iterative reconstruction algorithms. However, in cardiac MRI (CMR) not all coil elements of large coil arrays cover the heart and contribute to improvement of the image quality. Therefore, we hypothesize that an automatic coil channel selection can help do decrease the data volume and shorten post-processing times without compromising image quality.

**METHODS: Algorithm:** In CMR the size of the region of interest (ROI) shows a high inter-patient variability. Hence, a coil channel selection algorithm with a fixed number of coils may lead to unnecessary data in small patients or the lack of important information in big patients. To overcome this we developed a fully automated coil selection scheme for self-gated CMR that adaptively chooses a subset of the coil channels, which can contribute to the SNR of the heart region.

Figure 1 depicts the proposed scheme. The hypothesis of the proposed method is that in CMR the ROI that contains the heart and the surrounding vessels is subject to respiratory motion and can therefore be discriminated from surrounding anatomy such as arms or back based on the motion profile. In the current study this motion profile is derived from an additional readout signal along superior-inferior, which is also commonly used for image self-gating in CMR. A motion profile is derived for each coil individually and for the root-sum-of-squares (RSS) combination of all coils, with the method proposed in (1). It is known that the motion profile derived from the RSS-signal reflects the respiratory motion (1). In a correlation analysis between the RSS-profile and the individual coil profiles a sharp delineation between two subsets can be observed. One subset of the coils is not observing the same respiratory motion, e.g. by covering only the stationary periphery. The coil channel selection discards all coils with a correlation coefficient under an empirically chosen threshold.

**In-Vivo Imaging:** All imaging was performed on a 1.5T Philips Achieva system using a 32-channel phased array cardiac coil. To study the effect of the coil channel selection on the image quality, scans of the right coronary artery of seven healthy subjects were performed (2). A self-navigation signal was acquired at each heart-beat prior to the data acquisition. The coil channel selection was performed off-line by extracting the motion profiles from the self-gating signal and performing the described correlation analysis. The images were reformatted and a quantitative analysis of the vessel-length, vessel sharpness and the signal-to-noise ratio (SNR) in the right ventricle was performed using Soapbubble and MATLAB respectively.

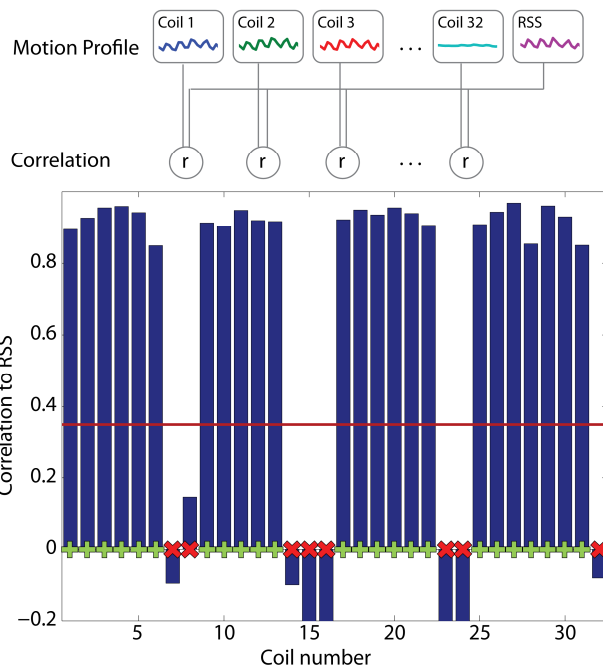
**RESULTS:** Table 1 shows the results of the quantitative image analysis of the coronary scans. No significant difference was found in the vessel-sharpness, the vessel length or the SNR. However, an average of 21 out of 32 coils was selected with the proposed algorithm leading to a data reduction of one third.

Figure 2 depicts a representative reformatted image of the right coronary artery using a) all 32 channels and b) subset of only 17 channels selected automatically based on the motion profile. The image quality in the heart and the quality of the RCA is comparable. However surrounding tissue was partially suppressed using the coil channel selection. In Figure 3 the difference between the scan before and after coil channel selection is shown. It can be seen that the coil channel selection discards signal in the area of the breast and the shoulders.

**DISCUSSION:** The threshold-parameter was chosen empirically in this study. However, it can be adjusted to customize the algorithm's behavior. A lower threshold causes more conservative coil selection, while a higher threshold causes more progressive selections. The present algorithm should not be confused with coil compression. While coil compression intends to keep *all* information and stores them more efficiently, the proposed method deliberately discards information, which is found to be irrelevant. Hence, coil compression can be performed in addition to the proposed coil channel selection to further reduce the data volume.

**CONCLUSIONS:** We have proposed a novel method for adaptive and fully automated coil selection in CMR. This enables a 34% reduction of the data size without compromising the image quality and potentially allows for accelerated data handling and post-processing.

**REFERENCES:** 1. Hardy, C.J. MRM, 2000; 2. Stuber M. JACC, 1999;

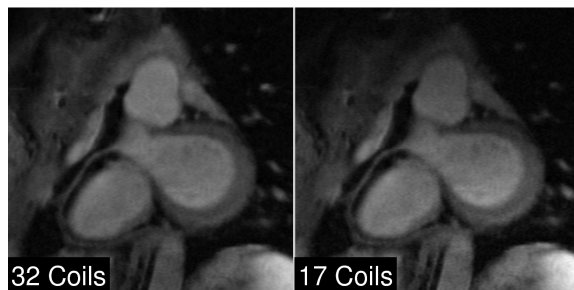


**Fig. 1:** Diagram depicting the coil selection algorithm. The motion profiles are correlated to the RSS-profile and included, if the correlation exceeds a threshold.

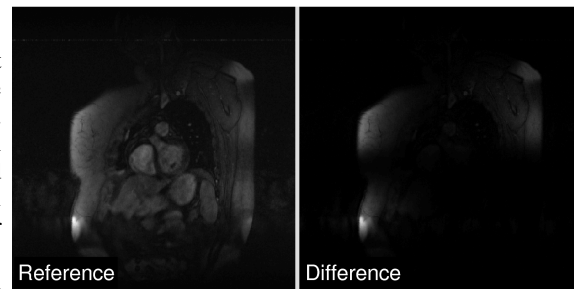
	Vessel Sharpness	Vessel Length	SNR	Coils
Full Information	0.365 ± 0.091	7.62 ± 2.55	36.2 ± 13.2	32
Coil Selection	0.374 ± 0.080	7.08 ± 2.54	34.6 ± 15.0	21.3 ± 6.5
Difference	2.4%	7.0%	-5.2%	33.5%*
p-Value	> 0.10	> 0.22	> 0.39	< 0.02*

\*indicates statistical significance

**Table 1:** Quantitative analysis of coronary MRI scans before and after coil selection.



**Fig. 2:** Representative reformatted coronary MRI scans before and after coil selection.



**Fig. 3:** CMR image with 32 coil channels and difference image to the corresponding image after channel coil selection. In this case 13 channels were discarded by the coil channel selection.