Reflected power as a breathing signal for motion correction in cMRI with GRICS

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Audience: MR scientist or engineer

Purpose: In cardiac MRI, pneumatic belt systems or navigators are used to measure the breathing cycle by volume changes and position changes of organs respectively. The positioning of the belt or navigating tracker or the non-physiological drift of the signal could lead to an unstable and unreliable respiratory signal. As shown in [1], the reflected power caused by impedance changes during RF transmission inside a birdcage coil can be considered as an input breathing signal for retrospective motion correction.

Method: A 3T MRI system (HDxt, GE Healthcare, Waukesha, WI, USA) was equipped with the SAEC system [2] to acquire synchronously respiratory and ECG data as well as acquisition window information in real-time for GRICS reconstruction [3]. A power sensor (Rohde & Schwarz, Munich, Germany) was connected on the internal directional coupler of the RF amplifier. The data was acquired with a LabView (NI, Austin, TX, USA) application and was transferred to the SAEC system via a RS232-connection. A FSE sequence was performed in free-breathing on a healthy subject and the reflected power at every Tx-RF pulse was acquired. For comparison, the signal of the pneumatic belt was also recorded during the scan. The data was reconstructed with the GRICS algorithm. In addition, we have quantified the correlation of the reflected power signal with the belt signal.

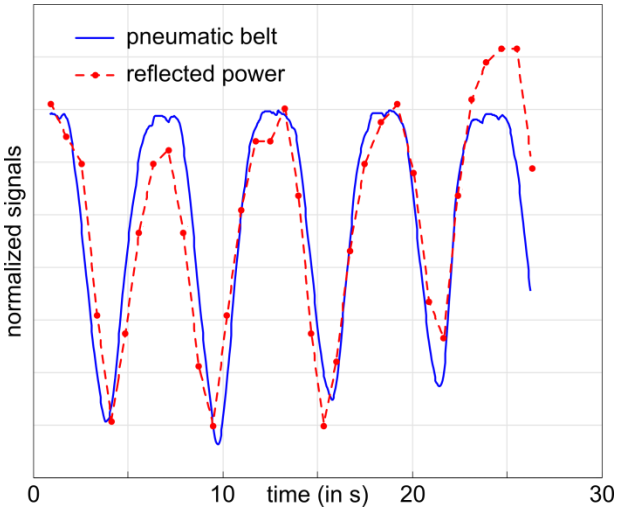

Figure 1: Comparison of respiratory belt data (blue) and reflected power (red)

Results: The reflected power of the birdcage coil corresponded with the data acquired with the pneumatic belt (Fig1) with R^2=0.78. Fig2 shows the uncorrected and GRICS corrected image respectively with significant reduction of respiratory ghost artifacts from anterior chest wall.

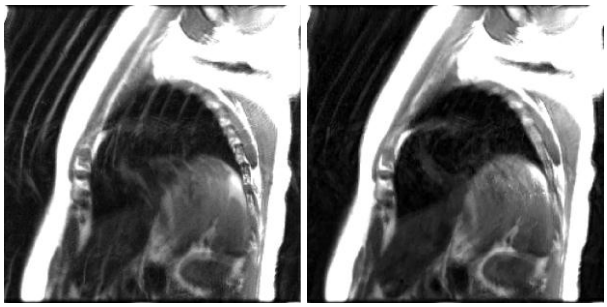

Figure 2: Comparison of uncorrected (left) and GRICS corrected (right) images of a free-breathing FSE sequence

Discussion: Since the information is only available during RF-transmission, this setup shows limitations on sampling rate (fs=1/TR; here fs = 1.26 samples/sec). Although this is sufficient for breathing , the tracking of the cardiac phase, as described in [1] would not be possible. Since in cMRI the patient is immobilized by the anterior coil and physiologic sensors, we can actually assume that the detected impedance change is caused by respiration only.

Conclusion: Impedance changes caused by respiration can be measured by the reflection of the transmitted power and used for retrospective motion correction. Since the sampling rate depends on RF excitation, sequences with multiple RF pulses (e.g. SSFP) or short TR could improve the sampling accuracy.

References: [1] Buikman et.al. [1988] MRI 6(3):281-289; [2] Odille et.al. [2007] IEEE Trans. Biomed. Eng. Vol45:630-640; [3] Odille et al. [2008] MRM 60:146-157