Stabilized decompositions for improved cardiac self-gating: A proof-of-concept in single breath-hold 3D cine imaging

INTRODUCTION:
With increasing interest in self-gated cardiac cine imaging, there is an ongoing need to always reliably and fast, self-gated (SG) acquisition is challenging. The measurement of the magnetic field gradient due to the blood flow is not always stable over time, which can lead to patient motion and breathing artifacts. For self-gated cardiac cine imaging, the SG signal is derived from changes in the magnetic field gradient and is used to gate the RF pulses. The SG signal is typically derived from an optoacoustic or an electrical signal, such as electrocardiogram (ECG) or respiratory sensors. However, the SG signal is highly variable and can be affected by patient motion, breathing, and other factors. To improve the reliability and consistency of the SG signal, various methods have been proposed, such as principal component analysis (PCA) and independent component analysis (ICA). These methods assume a certain degree of independence between the SG signal and the other signals, which may not always hold true. In this study, we propose a novel stabilised ICA (StabICA) approach to improve the reliability and consistency of the SG signal.

METHODS:
We acquired 3D cine datasets in N=5 healthy volunteers on a 1.5T clinical MRI scanner (MAGNETOM Aera, Siemens Healthineers, Erlangen, Germany). Single breath-hold (scan time=28s) 3D cine datasets were acquired in N=5 healthy volunteers on a 1.5T clinical MRI scanner (MAGNETOM Aera, Siemens Healthineers, Erlangen, Germany). Datasets were acquired with different single- (Empirical Mode Decomposition (EMD), Ensemble EMD (EEMD)) and multi-coil (PCA, ICA with novel stabilisation) decomposition methods. All datasets were compared with ECG triggers for evaluation. To compare the SG signal, we used a robust Bonett-Seier test of scale for paired samples.

Comparison of standard deviations with respect to ECG R-wave trigger for different decompositions on one dataset.

DISCUSSION/CONCLUSION:
Our proposed stabilised ICA approach yielded SG triggers with 66% lower variability (median over 5 subjects), although not for all subjects. This is a promising result, as it shows that our proposed approach can improve the reliability and consistency of the SG signal. This is particularly important for self-gated cardiac cine imaging, as the SG signal is highly variable and can be affected by patient motion, breathing, and other factors. Therefore, our proposed approach can improve the quality and accuracy of self-gated cardiac cine imaging.

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