Adaptive Filter Optimization of ECG Recordings during MRI-Guided Cardiovascular Interventions

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Introduction

MRI guided cardiac catheterization procedures offer a distinct advantage over traditional X-ray guided interventions due to an increase in soft tissue contrast and reduced patient exposure to ionizing radiation¹. However, due to a hostile electromagnetic environment created by the rapid switching of magnetic gradients, hemodynamic signals are difficult to monitor and record accurately.

These signals, including the ECG and invasive blood pressures, are important markers of patient health and provide valuable diagnostic information. Also, the QRS complex of the ECG is used to trigger some MRI sequences. Therefore, a system that can effectively eliminate noise induced from MRI sequences is necessary to allow for safe operations².

Objectives

- Reduce ECG noise through hardware and software solutions
- Identify noise present in different types of MRI sequences.
- Optimize the ability of a least mean squares adaptive filter to remove gradient induced noise through consideration of quality metrics.

Experimental Setup

ECG data was gathered from healthy volunteers and from anesthetized pigs undergoing experimental procedures. Electrodes were placed on the patients’ chest to provide nine leads.

Conclusions and Future Work

- Hardware setup for initial measurement of noisy ECG signals was improved with higher resistance to ground and longer leads to keep transmitting components away from MRI bore.
- Because of the noise amplitude change when the gain changed, it was evident that the gradients were primarily inducing noise on the inputs, making the noise a filtering issue rather than a shielding issue.
- Amount of noise generated by different sequences was examined, with the 3D Radial Whole Heart Scan inducing the most noise according to SNR.
- Real-time sequence noise was successfully reduced to allow for reliable recognition of QRS complex.
- Future studies will compare induced noise across patients and implement the hardware setup at a second testing site.

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References