Passive Coil-Based Wearable Textile for Monitoring Cardiac Activity

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The goal of this work is to explore a novel class of wearable textiles that are integrated with passive induction coils to capture cardiac activity and help diagnose cardiac conditions. These induction coils capture the magnetic field that is naturally emanated by the human heart and produce MagnetoCardioGraphy (MCG) signals that help distinguish between healthy and non-healthy cardiac activity.

To date, the most common approach for assessing cardiac diseases entails sensing of the heart's electric signals, namely electrocardiography (ECG) (M. Linzer et al., *Annals of Internal Medicine*, 126, 989–996, 1997). However, ECG can only capture cardiac signals in 2-dimensional view and typically requires extensive testing times for accurate diagnosis. To fill in this gap, MCG may be alternatively employed. However, magnetic fields that are naturally emanated by the human heart are extremely small, typically ranging from 0.1 pT to 300 pT. That is, they require shielding from the earth's magnetic field to be picked up. Indeed, state-of-the-art MCG devices, viz. Superconducting Quantum Interference Devices (SQUIDs), operate in shielded rooms and are immersed in liquid helium to achieve the desired sensitivity (K. Sternickel and A.I. Braginskli, Supercond. Sci. Technol., 19, 160-171, 2006).

In this study, we take a major step forward to demonstrate the feasibility of monitoring MCG in non-shielded environments. Our work builds on (J. Mooney et al., 3, 1-10, 2017) and envisions a wearable textile vest that can: a) monitor cardiac conditions on the go, and b) assist in the diagnosis of conditions that are hard to identify using conventional ECG tests. Proof-of-concept investigations demonstrate the feasibility of detecting MCG activity using only two induction coils and an ECG trigger. The first coil is used for MCG signal pick-up, the second coil is used for noise signal pick-up, while the ECG sensor is used to provide a synchronization clock. Using this ECG trigger, signals collected by both coils are averaged over several cycles, and eventually subtracted. Following Digital Signal Processing (DSP), MCG is detected in a seamless and non-shielded manner. At the conference, we will expand on the operating principle of these coil-based wearable textiles, and we will present extensive measurement results.