Non-invasive Home-Based Maternal-Fetal ECG Monitoring System

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One out of 125 infants is born with some form of congenital heart disease (CHD). Many neonates with CHDs do not show obvious symptoms, and more than 50% of affected newborns are discharged from the hospital undiagnosed. In fact, CHDs originate in early stages of pregnancy when the heart is formed (~5th week of pregnancy) and they can affect any part or function of the myocardium. The defect may be insignificant; the baby appears healthy for many years after birth but the defect may cause sudden death at any time throughout life. Or the defect may be so critical that the baby's life would be in immediate danger. Therefore, continuous monitoring of the fetus' heart functionality during pregnancy would provide not only information about the well-being of the fetus, but also insights into the investigation and prevention of CHDs. Nevertheless, the common practice (known as cardiotocograph – CTG, utilized in over 85% of labor episodes in the U.S) which is used to assess the fetus' heart, only provides intermittent recordings of fetal heartrate (fHR) and HR variability (HRV), thus not effective to diagnose and monitor the development and health of the fetus.

In this context, we develop polymer patches embedded with non-contact electrodes (NCEs) to capture the combined fetal/maternal electrocardiogram (f/mECG) and the separate mECG. The f/mECG data are transmitted via Bluetooth Low Energy (BLE) from the abdominal patch to the wrist device where the mECG is collected. The signals are enhanced by the wavelet de-noising technique and then the fECG is extracted through signal processing with the mECG as the reference. Rechargeable Li-polymer batteries are used. All the collected data are sent to a smart device connected to the cloud-based server. Different from contact ECG approaches which are dependent on the electrode-skin interface, NCE ECG could be obtained without any skin effects (sweat, hair, etc.), making our system favorable for off-the-clinic measurements as well as a novel tool to assess the wellbeing status of the fetus and mother in the community, especially with resource-poor populations. The conceptual design is showed in **Fig. 1a** while **Figs. 1b and 1c** show a sample recording raw combined data and a simple extracted ECG.

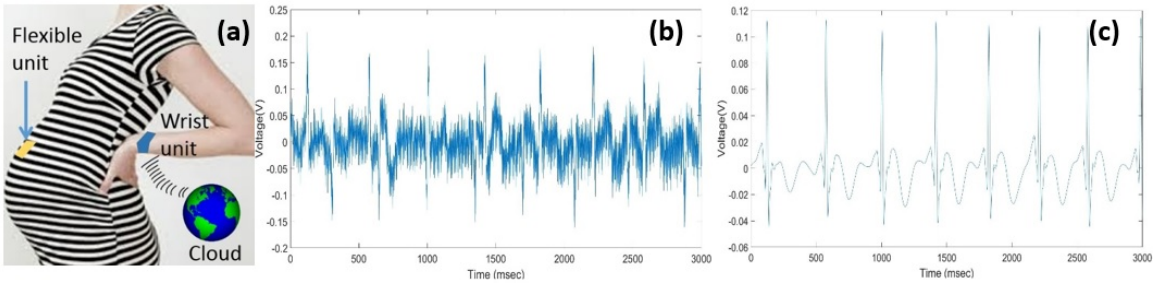

Figure 1. a) Conceptual design of the system. **b)** Raw data of a recorded combined ECG mimicking that of f/mECG and **c)** A de-noised and extracted ECG using the other ECG as the reference signal.