Creating a High Fidelity Portable Electrocardiogram Analysis System

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Inexpensive and portable heart rate monitoring devices that are used for fitness applications only measure heart rate. On the other hand, medical-grade electrocardiogram (ECG) instruments measure the QRS complex, and are used for the diagnosis of various heart conditions including atrial fibrillation and heart arrhythmias. These ECGs, which cost about $200 to the patient, are based on only a ten second observation and do not necessarily provide an accurate representation of the patient's long-term heart health. However, both of these monitoring devices are based on the same principal of measuring extremely small differential voltages. Their front-end integrated circuits are low-cost and freely available. This provides the opportunity to develop an ECG instrument that is portable and inexpensive like a fitness device yet approaches the same fidelity of a medical ECG. This project used low-cost integrated circuits to sample the ECG waveform at a high rate. Digital signal processing algorithms were then used to suppress noise and extract the QRS complex. These results were then compared to a professional ECG and the measurements were consistent. Further development of this prototype that enables long-term, non-invasive monitoring could be used to find intermittent medical issues and provide insight about their correlation to the QRS complex. These include the onset of strokes, heart attacks, anxiety, and depression. Because high sample rate continuous monitoring generates large amounts of data, machine-learning algorithms could be applied to automate the diagnostic process and alert medical professionals.

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