Wireless ECG

Interim Report

by

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Background

Routinely, the cycle of a heart is measured in a clinical setting using an electrocardiogram, or ECG. However, ECGs require 10-12 wired probes placed in direct contact with the skin. This requires irritating adhesives, conductive gels, and may require special treatments such as shaving the chest of the patient. Because of these factors, ECGs are typically stationary devices and are not suited for long term monitoring. It is important, however, to continually monitor the heart signal of patients at risk of cardiovascular arrhythmia or other heart diseases. An ideal solution would involve a durable portable system that could be used by a patient without assistance and with a minimum of training.

Motivation

The principle motivation for this project is to develop a method of monitoring heart activity for patients with heart disease, pacemakers, and other special heart conditions so the patient can lead a relatively active life without being confined to a specific region. The current 12-lead ECG systems in use are uncomfortable, non-portable, invasive and unsuitable for long-term use. By being able to monitor sickly patients remotely, peace of mind can be offered to extended family knowing that emergency services can be dispatched in the event of cardiac arrest, or irregular heart patterns.

Scope

To that end, the project that our group has chosen for ELEC 399 is a Wireless Electrocardiogram. The purpose of this device is to transmit data about a person's heart rate in real time, using non-intrusive, low power, band-aid sized probes to a smartphone. The smartphone will receive the output from the ECG via bluetooth and either store it for later analysis or upload it for analysis in real time. The smartphone will also be able to detect when the output indicates a medical emergency, such as cardiac arrest, and call an ambulance on behalf of the patient.

Deliverables (Tentative Schedule)

Electrode design (Week of Oct. 22)
Amplifier design (Week of Oct. 29)
Filter design - collaboration with software team (Week of Nov. 05)
Bluetooth transmitter (Week of Nov. 12)
Microcontroller choice (Week of Nov. 19)
System design (Week of Nov. 26)

Work Plan

- Develop an electrode that can be mounted long term that is non-invasive.
- Find compromise between number of leads and clarity of signal (more leads = more clarity).

- Collaborate with software team for filter design.
- Choose microcontroller for A/D processing for interconnection between electrode and blu-tooth device.
- Combine hardware components for overall system design.

Hardware will be the main focus of our group, while group #12 will focus on the software aspect.

Alternative Approaches

iPhone ECG
A method that already uses a smart phone as an ECG is currently in development by AliveCor. It works by attaching two oblong metal bumps, which act as electrodes, to the back of an iPhone. The iPhone screen acts as the ECG monitor and can transmit the cardiac data of a patient immediately to a base station. In a place such as a hospital, this would be a quick alternative to the larger ECG systems that need to be carted into a patient's room. It requires less preparation and is highly portable. The downside to this system, in comparison to our design, is that it does not constantly monitor a patient's cardiac data unless an iPhone is strapped to their chest. This device does not serve as an appropriate long term device.

Eric Topol, MD, who is one of the doctors testing this device, used it once on an airplane to determine if someone was suffering a heart attack. By applying this device the flight was forced to make an emergency landing, and the person's life was saved. A major upside to this device is that it can quickly determine the severity of a cardiac condition, such as whether a person is simply suffering from heartburn or if they are under cardiac arrest.

SmartPad
A team of MIT students developed an ECG monitoring system that goes on hospital beds in order to monitor vital signs. The electrode is placed on the bed and the patient lies upon it, alleviating the intrusiveness of traditional ECGs. This system works well for long-term use and is easy to setup, but does not allow the patient to be mobile. The primary use of this system is during surgeries as the wireless pad gets rid of the awkward wires of current systems. The SmartPad is similar to our proposed project, but lacks the mobility it requires, as the patients must be immobile in bed with the pad underneath them for it to work properly.

LifeTouch HRV011

LifeTouch is a commercially available wireless ECG that is designed to provide continuous monitoring of patient after they leave intensive care. The system is similar to a very large band aid making it physically very portable, but portability is limited to areas with wifi coverage by the wireless interface. Our project will expand on the basic principles of this device by using a smartphone for signal processing and data transmission which will allow more power for signal processing and better mobility using mobile data.

References

Winston De Armas McMaster, “University Design of a Non-intrusive 2-lead ECG System Using the Active Insulated Electrode”, 4-22-2010

Fred Chen, Student Member, IEEE, Henry Wu, Pei-Lan Hsu, Brad Stronger, Robert Sheridan, and Hongshen Ma (August 20-24, 2008), *SmartPad: A Wireless, Adhesive-Electrode-Free, Autonomous ECG Acquisition System* [Online] Available: http://web.mit.edu/2.75/past_projects/IEEE_EMBS_2008_Chen.pdf

Heathcare IT, (May 10, 2011), *Isansys Lifecare Launches LifeTouch* [Online], Available: http://mwrf.com/content/band-aid-heart-monitor-makes-easy-work-ecgs-while-collaborations-advance-communications,

C. Steele, (2012, March 26). *9 Life-Saving Technologies for Doctors* [Online]. Available: http://www.pcmag.com/slideshow/story/295802/9-new-life-saving-technologies-for-doctors/1

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Supervisor's name (Print) Signature Date

Notes for the supervisor:

1. Please return the marked hard copy to Prof. Tao Lu by Monday, October 23.
2. Attached additional pages for comments if necessary.