

University of Pennsylvania
Department of Electrical and Systems Engineering

ESE SENIOR DESIGN PROJECT - ADVISOR PROJECT SUBMISSION FORM

1. Project Title: iBOD: Medical Wireless Sensor Networks

2. Proposer's Name: Prof. Rahul Mangharam E-mail: rahulm@seas.upenn.edu

Are you willing and able to serve as advisor for this project? Yes; No

3. Brief Project Description:

In the next decade over 70 million Americans will be 65+ years and 8 out of 10 will have one chronic disease. The goal of this project is to design a flexible and wearable smart band-aid to monitor the patient's body vitals at all times. The project involves the design of an Electrocardiogram (EKG) monitor with motion sensors and embedded software for signal processing and wireless networking. Each health-strip has a microcontroller, low-power radio, EKG and body activity sensors. The health-strip will monitor the patient and alert the doctor, ER and send all data to a remote database via the low-power transceiver. The system will run a real-time sensor operating system that already exists but will need to be enhanced for medical applications so the device can be programmable remotely. This is a project in real-time embedded systems and wireless networks. If you have interests in the designing future medical devices and real-world embedded system design, this is the project.

This project will use the MedSim 300D Patient Simulator for ECG signals input into the ECG monitor. We will no conduct any tests on humans or animals. If the need arises for human involvement in tests the appropriate IRB clearance will be sought.

4. Project Design Objectives:

The project is divided into three iterative and overlapping phases:

1. The design of EKG hardware with an accelerometer. We will first design a test circuit board to ensure the correct functionality of both the analog front-end to reliably sense the EKG signal and the digital electronics to process the signal, extract features and determine basic cardiac arrhythmias (e.g. arterial fibrillation). The second and third generation boards will focus on flexible circuit board design, body comfort and reliable electrode contacts.
2. An embedded system is only as smart as the software that it runs. We will use a Real-Time Operating System on the microcontroller to manage sensing, processing and networking tasks. We will begin with basic sensing, processing and packet communication to a gateway node. Following this we will refine the software to do stream-based signal processing at run-time and raise alerts or log cardiac events.
3. As we get the hardware and software to work together we will work with Electrophysiology Department (Dr. Edward Gerstenfeld) the Hospital at UPenn to use the device on patients with complex arterial fibrillation problems.

Over the longer-term this class of continuous care cardiac monitoring devices can be used for a variety of applications, namely:

1. Chronic Patient Care

- Baby Boomers (+60 years) with repeat attacks

2. Drug Trial Patient Monitoring

- Monitor side-effects of cardio-active drugs such as Vioxx™, Viagra™ and Celebrex™

3. Monitor Defibrillator Performance

- Monitor cardiac arrhythmias and defibrillator response for arterial fibrillation

4. Continuous Care Database

- Long-term patient data for quantitative and machine diagnosis – no such database exists today.
- Competitive medical device testing on long-term medical data

5. Project Prerequisites:

What specific knowledge (e.g. courses or topics) and skills (e.g. programming languages or software packages) will this project require? Please rank order the knowledge and skills you have identified, with the most important at the top of the list.

The ideal candidates would have a strong willingness to learn, try new and unconventional approaches and cross the boundary between engineering and medicine. A good grasp of C, no fear of programming and hardware design would be essential. You do not need to know everything mentioned above because then it will not be research ☺ Knowledge of signal processing basics and Matlab would be a plus.