RUTGERS

School of Engineering
Department of Electrical and Computer Engineering

Capstone Project Proposal

Project Number: S16-033

Project Title: Guardian: Continuous Health Rate Monitoring

Project term: Spring 2016

Student names (last and first name) and contact information (please start with the team point of contact):

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2. Peter Nguyen
3. Paolo Umali
4.
5.

Project Advisor(s) name(s):

1. Mehdi Javanmard
2. Hana Godrich
3.

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This section should include a one page (max) description of the project.

Overview

Sudden cardiac arrest (SCA) is the number one leading cause of death in the United States, causing approximately 326,000 deaths yearly. "SCA is a life-threatening condition--but it can be treated successfully through early intervention with cardiopulmonary resuscitation (CPR), defibrillation, advanced cardiac life support, and mild therapeutic hypothermia. When bystanders intervene by giving CPR and using automated external defibrillators (AEDs) before EMS arrives, four out of 10 victims survive." (http://www.sca-aware.org/about-sca)

The main objective of our project is to construct a health-monitoring device to continuously monitor and sync the user's heart rate data to a mobile application that will allow the user and others to monitor the user's heart rate. By allowing others to monitor the user's heart rate, alerts can be sent to emergency services and those monitoring the user's heart rate to quickly react to the situation.

The mobile application we aspire to develop will serve the sole purpose of monitoring heart rate with limited functionality. The reasoning behind creating a mobile application with one sole purpose is unique: in order to continuously monitor a user's heart rate, we must alter the health monitoring device to continuously run at all times of the day. In essence, the user never needs to take the device off, but to successfully allow for the device to continuously run there must be limited functionality to prevent tremendous energy consumption.

The sub objective of our project is to develop a unique way to harvest energy without having to remove the health-monitoring device from the user. This will allow for complete and full functionality of continuously monitoring the user's heart rate. There are a few ideas, which seem plausible for energy harvesting:

1. Using the body's heat, we can convert the heat into energy that can charge the health-monitoring device. (E.g The Puck)
2. Using motion, similar to swinging your arm to power an automatic watch, we can convert the kinetic energy gained by movement into power for the health-monitoring device. (E.g AMPY MOVE)

Required Equipment (Hardware & Software):

- adafruit – heart rate educational starter pack with polar wireless sensor (online starter kit)
- Arduino microcontroller
- Power supply source to supply power into health monitoring device
- Mobile Application Platform (Android, iOS, or Windows)
- Database/Server to store data
- GPS/Bluetooth controller

Additional Information Needed:

- Statistics from doctors / physicians / literature / cardiologists about heart attacks while sleeping
    - E.g 20% of heart attacks happen while sleeping and can be prevented with 24 hour continuous monitoring (hypothesis)
- Why would people want to use our device rather than other on the market devices?
    - Simplistic and easy to use/set up, does not target a single audience, incorporating health monitoring device with self charging has not yet been implemented
- Why haven't people done it before?
    - Harvesting energy is difficult with today's technology
- Google search: Heilmeier questions
    - What are you trying to do? Articulate your objectives using absolutely no jargon.
    - How is it done today, and what are the limits of current practice?
        - Not done today, but limitations is energy harvesting
        - Problem may be consuming more energy than producing/absorbing
    - What's new in your approach and why do you think it will be successful?
        - Integrating multiple (if possible) power sources to increase dependability
        - Both kinetic AND thermoelectric energy
    - Who cares? If you're successful, what difference will it make? What are the risks and the payoffs?
        - Will drastically affect the world today – everyone can wear it as long as they have mobile device with data
        - Can save lives through alert system/ notification to user's guardians/important people
    - How much will it cost? How long will it take? What are the midterm and final "exams" to check for success
        - Check below for cost
        - Should take entire semester to complete
- Search for the Top 10 wearable health rate monitoring devices
    - Microsoft Band, Fitbit, TomTom Spark, Garmin Forerunner 225, Mio Alpha 2, Samsung Gear S2, Apple iWatch, Moto 360 Sport, Sony SmartBand 2, Jawbone UP3 & UP4
- Not creating new hardware; however, we are designing a new algorithm to process data at real time – abnormalities in heart rate, then we will send signal / alert services (EMS)
    - Sort of creating new hardware if we go thermoelectric path
- What would this project be useful for in the real application?
    - To prevent and quickly respond to heart attacks/panic attacks/sudden cardiac arrest/ any cardiovascular problems related to in increase/decrease in heart rate

Scope of Work (SOW) (Grading scheme for A):

1) Utilize on the market tools to create a heart rate monitor
    1. Use sensor from adafruit
    2. Use arduino uno r3
    3. Utilize on the market software to display heart rate
2) Incorporate Bluetooth to be able sync heart rate information wirelessly
3) Create a mobile application that displays heart rate information based on blue tooth heart rate information
    1. Application will display information such as below:

4) Incorporate or create a kinetic energy charger that will power up the heart rate monitor device
5) Make the wearable device fit on your arm – this means incorporating the board, the wearable device, Bluetooth, and everything onto a single wearable band that will be powered by the kinetic energy charger. The mobile application will display the heart rate of the user
6) ~~Working in parallel with 5), we must create security protocols to prevent unwanted people from viewing your heart rate~~
7) ~~Do we need database? We do not want to keep heart rate information for more than a day – if doctors want that, then they must upload information to database via button on mobile app. We can create a button that allows for extraction of data.~~
8) Create an alert system that will notify those who are monitoring the user if the user's heart rate stops – can incorporate EMS and/or medical services to be alerted.
    1. Additionally, we can create a sound system on the armband that will sound if the heart rate stops. This will allow others nearby to run to see what the noise is.
    2. Create 2 switches on the arduino or breadboard that allow for users to see their heart beat (demonstration purposes) and another switch that will allow for flatline sound if heart rate stops. This sound will only sound if user's heart rate stops.
    3. We would need a GPS tracker to pinpoint the exact location of the user when the user's heart rate stops or alert system goes off.

Upcoming Items Due:
- February 5, 2016 – Project Abstract to be submitted to advisor by the team POC
- Week of February 15, 2016 – Project Presentations session I

On the week of February 15, 2016:

a) Phase 1: Get organized with final project Scope of Work
   a. Allocation of team member responsibilities
      i. Paolo
         1. Create heart rate monitoring mobile application
         2. Bridge together software with hardware
         3. Create and design UI for mobile application
      ii. Peter
         1. Engineer for creating the hardware
         2. Ensuring all components (GPS, Bluetooth, Power supply, heart rate monitor reader) working together
         3. Create and design Guardian
      iii. Jon
         1. Gathering all necessary deliverables for project to go underway
         2. Ensuring team meets deadlines and due dates
         3. Communicating with advisor/prepare documentation, reports, etc.
         4. Work on design of UI for mobile application and design of Guardian
   b. Project Design Objectives and Constraints
      i. Objective: Create a continuous heart rate monitoring device that is powered by either thermo-electric/kinetic charging power source
      ii. Constraints: Harvesting enough power to continuously power the device
         1. Drawback to peltier modules is that they are inefficient (10% efficiency for converting to energy)
   c. Cost:
      i. Arduino Uno - $10
      ii. Heart Rate Sensor - $20
      iii. GPS - $40
      iv. Bluetooth (low energy) - $20
      v. Mobile Application Platform – free to $100?
      vi. Peltier Modules - $20/Piece
      vii. AMPY MOVE - $100
      viii. Wires, tools, circuit items - $10
      ix. **Overall Cost - $120 - $300**
   d. Deliverables:
      i. Wearable heart rate monitoring device that will never require you to take it off and syncs continuous heart rate to your mobile device via Bluetooth. Can pinpoint your exact location when your heart rate stops or drops.

Important Links:

Body Heat (Thermo-Electric Energy):
https://www.youtube.com/watch?v=YhynSkFlJOs&ab_channel=thermoelectrics (quick explanation of what thermo-electric energy is)
https://www.youtube.com/watch?v=dBe5ZUw8avU (example of thermo-electric energy)
https://www.youtube.com/watch?v=DsVvBZQkHaM&ab_channel=DarkZeros (similar to what we want to create)
https://www.youtube.com/watch?v=_FakHQjafto

Arduino Heart Rate Sensor:
https://www.youtube.com/watch?v=RCnuk0e85HE (shows actual sensor)
https://www.youtube.com/watch?v=aSSRPKDGEwk&ab_channel=SumeruLabs (shows desktop app)
https://www.youtube.com/watch?v=2_c0yE9QHNI (coding for sensor)
https://www.youtube.com/watch?v=Jl62rPXQ5BQ (android + arduino)
https://www.youtube.com/watch?v=g1jO7OEZNyE&ab_channel=WKHsu (Bluetooth + sensor)
https://www.youtube.com/watch?v=OsMoowoB2Rg&ab_channel=PaulMcWhorter (GPS + sensor)

Arduino Alert System:
https://www.youtube.com/watch?v=Vk1fpPXUIJU (sounds)