Low Cost Portable ECG - Project Plan

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**Client:** Dr. Rakshak Sarda / Benjamin Sjulson

**Advisor:** Mani Mina

**Team:** Aaron Melcer

Donathan Morgan

Ian Abbott

Keegan Mumma

Nic Dubois

Seth Rickard

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# Project Statement

This project is intended for us to create a Low Cost Portable ECG Monitor to detect Atrial Fibrillation. Over 33.5 Million people in the world have been diagnosed with Atrial Fibrillation, a heart condition that causes it to beat irregularly and sometimes causing death. Many people in poor areas do not have access to the proper technology to test for Atrial Fibrillation, and can live many years with this undiagnosed condition. By building a low cost ECG monitor, it will be possible for people to identify and diagnose this condition and receive the proper care. We will be utilizing bluetooth on both the monitor and a smartphone to read a heart signal and identify if there are any problems with the heart. A usable ECG monitor that can be made and repeatedly used at a low cost can save many lives and make the world a greater place.

# System Requirements

## Project Requirements

There are two major components to this project. There is a hardware aspect, which is the actual monitor and leads that will be connected to the body, and a software aspect, which is the smartphone application and the reading of data transmitted by the monitor. The software team is composed of three computer engineers, Seth Rickard, Ian Abbott, and Keegan Mumma. The app will need to be able to connect via bluetooth with the ECG monitor and read and sort all the heart signals that are being transmitted. If there is an incorrect heartbeat or a noticeable change from a normal rhythm, the app will notify the user of an error. The app should have an easy to use interface and ideally would show a live transmission of the heartbeats that the monitor is reading. The hardware side has a couple different requirements. The team consists of three electrical engineers, Donathan Morgan, Nic Dubois, and Aaron Melcer. The design needs to be small enough to fit on a chest and preferably over clothes. We currently have a circuit chosen with calculated values for resistances and capacitors that will hopefully lead us in the right direction. Once the circuit is built and tested, it’s a matter of sizing and making the most compact and affordable monitor possible. There are a number of components that must be considered in order to make the monitor the most effective it can be. A proper battery, ideally rechargeable, must be used and have the ability to be charged by a micro-USB standard phone charger. The monitor must also account for bluetooth and transmit the acquired data to the app in order to be analyzed. Once this is complete, an enclosure must be made that accounts for the leads to the body and is lightweight and comfortable.

## Assessment of Proposed Solution

There are many strengths and weaknesses in the solution above for an ECG monitor. The strengths are that it is a fairly simple designed and the majority of the circuit hardware can be implemented quickly and can get us to the testing phase relatively fast. The weaknesses that we believe to exist are the choosing of a couple specific resistor and capacitor values that were calculated but will not be completely valid until after the testing phase begins. Regarding software, a weakness is that we need to determine the proper microcontroller that can be used to control the received signals. Once chosen, it should be very easy to see whether the correct microcontroller was used.

## Validation Acceptance Test

Each subsystem of the physical device will be tested through Matlab and Simulink. This is limited to the amplifier and the power systems. The microcontroller subsystem however, will have to wait for a prototype board to be spun out to be programmed and tested. The software solution is able to be tested with junit tests for the most part. A stubbed out bluetooth device will be used to test the connection manager and develop the protocol. End to end and final acceptance testing will be put off into the second semester for a physical prototype to be spun out and programmed. Finally real world tests will be conducted on the developers, by hooking the device up to them and measuring their heart beat.

# System Description

The proposed system will consist of a physical measuring device and a software application for an Android device. The physical measuring device will consist of three major subsystems; the amplifier, power solution, and the control unit. The amplifier will consist of multiple conventional filtering techniques, and the leads to the subject. The amplifier’s job is to amplify the electric signal from the subject and filter out gross errors in the waveform. The power solution must be compact and rechargeable, with an emphasis on the end user’s use case. Meaning that the power solution should be rechargeable by a common micro usb connection, much like a phone. The final subsystem of the device is the control unit. This will consist of a microcontroller whose purpose is to digitize the output of the amplifier and transmit the data to the paired android device. The Android application will also consist of three subsystems; the connection manager, sensing algorithm, and graphical user interface. The connection manager will be responsible for keeping track of the paired physical device. The connection manager must be a daemonizeable process that monitors the stream of data from the device and raises a signal to the algorithm when new data is received. The sensing algorithm subsystem is designed to take the data from the connection manager and track the user’s heart. If an irregularity in the rhythm of their heartbeat is detected the, algorithm subsystem is responsible for notifying the user that an irregularity has occurred. This subsystem may also be extended to allow for doctors to keep remote records of their patients’ heart rates. The last subsystem is the graphical user interface, this would allow the user to view the current waveform of their heartbeat and old waveform data. The graphical interface will also allow the user to pair the android device with the hardware solution described above.

# Work Breakdown Structure

## Project Schedule

In gross terms, we plan to complete a prototype of the physical device and a preliminary Android application by the end of the first semester (December). This then leaves the second semester for the interconnection and testing. The first goal for the physical side is the development and testing of the amplifier. The second goal is the design of the power system. And the final goal for the first semester is production of a physical prototype. The first goal for the software side is the development of the gui. The second goal is designing the connection manager and determining the message structure for the communication between the application and physical device. The second semester will be devoted to designing the detection algorithm and programming the microcontroller on physical device and end to end testing. Programming the microcontroller is blocked until a prototype is available because we do not have a development board.

Risks/Feasibility Assessment

We believe that our project goals are completely obtainable and they may even be a bit excessive for the hardware side. The project has not caused any major challenges as of now, only causing us to decide on different methods of design. The feasibility level is very high because both teams are confident that they can finish their parts in the amount of time as stated in the project schedule.

## Cost Considerations

Prototyping the software side of the project is simple due to the ubiquity of android devices. The amplifier and power solution are also easily prototyped with components available at the electronics shop. The real challenge appears when prototyping the physical board with the microcontroller, the housing, and the end to end testing. A rough breakdown of cost predictions for prototyping follows:

|  |  |
| --- | --- |
| Component | Estimated Cost |
| Microcontroller | $5 |
| Various Electrical Components | $20 |
| Batteries | $4 |
| Enclosure/Case Materials | $10 |
| Prototype Boards | $60 |
| Micro USB Battery Charging Module | $2 |
| Heart Monitor Leads | $15 |

Once prototyping is completed, the cost of the individual components will be much less than what is listed here. It is assumed that multiple prototype boards will need to be spun out.

# Market/Literature survey

As of now, there are no low cost ECG monitors on the market for sale that we could find for under $50, and the ones that are close do not have any noticeable atrial fibrillation detection method.. There have been numerous reports and studies, but we cannot find a solid document that shows that they are currently being used or on the market. We believe that this design will be the first of it’s kind to help and diagnose Atrial Fibrillation for poverty-stricken areas.

# Conclusion

Atrial Fibrillation is an extremely dangerous condition that goes undiagnosed in most of the world, and especially lower income areas. A low cost diagnostic method would greatly increase the rate of diagnosis in these areas and allow the affected to seek treatment. With this project we hope to help many people get the diagnosis they need, and seek treatment.