EE / SE 491 Week 2 Status Report
Feb 11, 2019 - Feb 15, 2019
Group: sddec19-20
Project: Ultra-thin electronic skin for real-time health Monitoring
Stakeholder/Client: Liang Dong

Team Members:
Sovann Chak
Omar ElSherbiny
Justin Gordon
Sungmin Kang
Sangwon Lee

Passing Week's Accomplishments

Software Engineers

(Sovann)

- Stakeholder discussed applications design and look, however, not much input was provided in regards to look or technology to use. Thus allowing us creative freedom.
- Stakeholder focused the discussion towards the EE's aspect of the project.
- Researched iOS application development and began to learn Swift to develop a rudimentary application.

  https://developer.apple.com/library/archive/referencelibrary/GettingStarted/DevelopiOSAppsSwift/

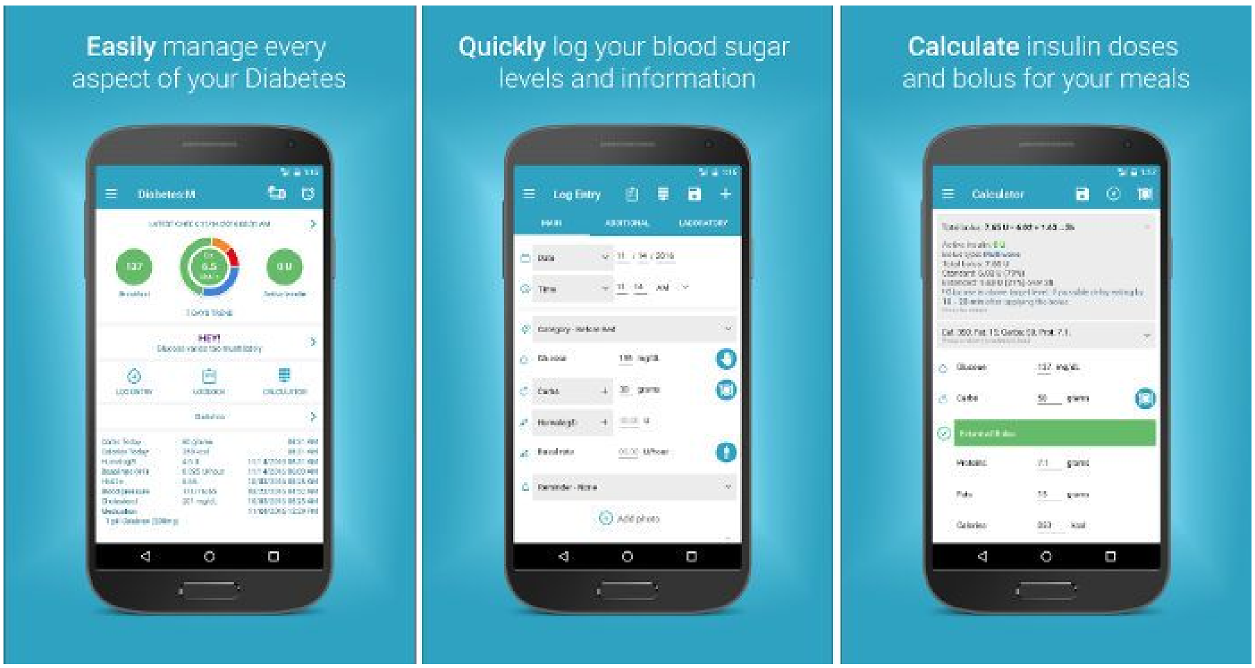
- Ultra-thin wearable will most likely use bluetooth to communicate with the application thus I have been studying the iOS bluetooth API for low power usage devices

  https://developer.apple.com/documentation/corebluetooth

(Justin)

- Began initial design process for application. Application must have an easy to use interface and be accessible for the target audience. Included below is a design in which I believe to be a good launching point to us to draw from for our application that the Ultra thin wearable will communicate with in order to monitor the different aspects of the project.

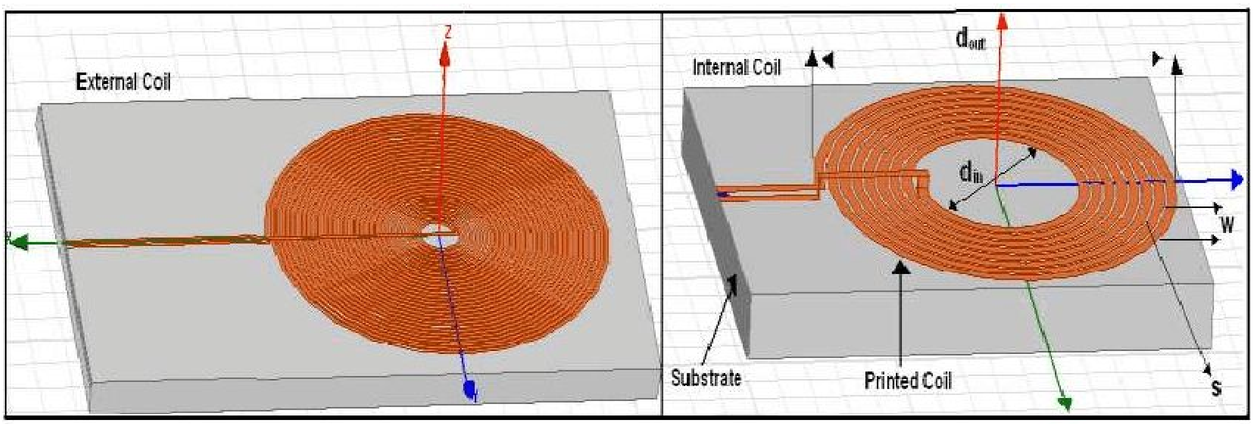
  (Some inspiration for the design)



- Researched Android technology including programming conventions, languages and devices used during the communication needed for our application.
- Android development is primarily written in Java. Being widely used, Java will provide us with ample amount of libraries to utilize in construction of our app.
- Creating a usable product includes ease of navigation and readability. Looking through applications that are similar to ours gives us insight to what users are looking for in an interface. Applications will use different pages to display data from the various measurement. For example we may have a page dedicated to ECG measurements where all relevant data will be available to the user.

Electrical Engineers

(Omar)

- Discovered that one of the lead biomedical researchers are leaving the university due to funding. Thus, we will have to meet with a different team member.
- Met with professor Nathan Neihart who specializes in RF design, and discussed possibly implementing one of his research projects into our design.
- Dr. Neihart aims to use coupled inductors to detect minerals in soil. The stems from the fact that electrical properties of capacitors change depending on the dielectric material between the capacitor's plates. $C = \varepsilon A/d$.
- A self-resonant frequency of an inductor exists because there is a parasitic capacitance between the windings of an inductor. If we are able to link the how the electrical properties of an inductor changes depending on the material surrounding it then we can correlate electrical power to levels of electrolytes in human sweat.
- The coils will not look like conventional coils where wires are wound circularly to create a "hollow tube." Instead, the coils will be printed in a fashion similar to what is shown in the figure below.
- 

- With this design a challenge presents itself since there is no understanding of the physics behind these coupled high frequency inductors, which is what Dr. Neihart attempts to tackle in his research. Hence, there is an opportunity to contribute to the understanding of such a device, and possibly get our work published.

(Sungmin)

One of the basic sensor for human body is ECG. In addition, we can apply this kind of sensor at so many devices. For example, in Apple Watch, there is ECG sensor, so people can check their heart rate very easily.

(https://www.cnet.com/how-to/apple-watch-ekg-what-is-ekg/)

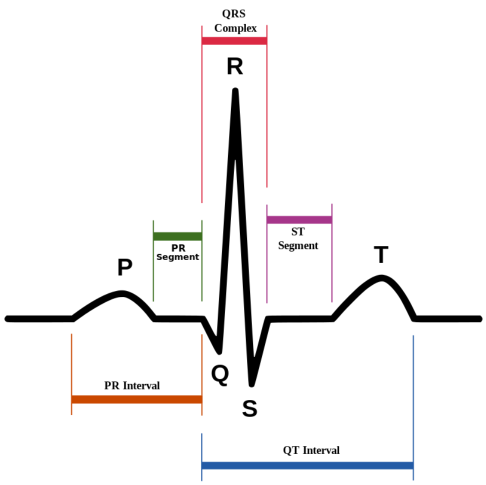
Also, I thought we could apply this kind of sensor in our ultra thin skin human body sensor, so I checked the ECG algorithm in terms of signal processing such as filtering at the Matlab. Even we do not use this kind of sensor in our project, we may do similar sensor with ECG, so I thought studying about this filtering will be helpful. I used Matlab reference page to understand this signal processing.

There are four stages such as band-pass filter, derivative, squaring function and moving window.

Band-Pass Filter - Cascaded low-pass and high-pass filters for rejecting influence of muscle noise.
Derivative - QRS complex slope information
Squaring Function - Non-linear amplification of output of the derivative emphasizing the higher frequencies
Moving Window Integrator - To obtain waveform feature information in addition to the slope of the R wave

https://www.mathworks.com/help/dsp/examples/real-time-ecg-qrs-detection.html

(Sangwon Lee)
First of all, since we have to know what kind of data (bio-signal) that we can collect from our body to analyse and use for health diagnose. ECG which collect signal data from human heart, it has 5 big segments. PR interval, PR segments, QRS complex, ST segment, and QT interval. There is normal signal for ECG below/



https://www.robots.ox.ac.uk/~gari/teaching/cdt/A3/readings/ECG/Pan+Tompkins.pdf

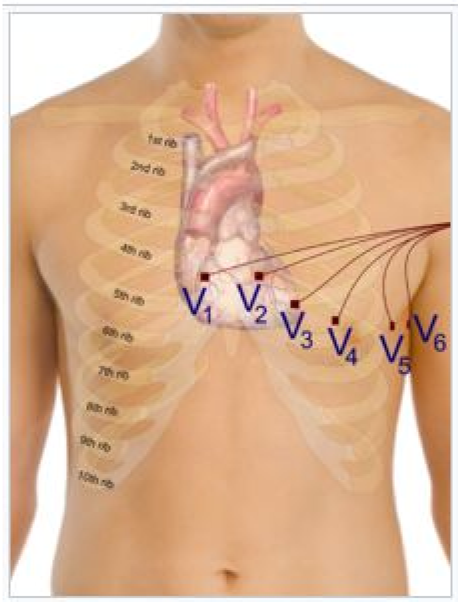
And each signal came from different body parts. And signals are listed below.

- O is the origin or datum point preceding the cycle
- P is the atrial systole contraction pulse
- Q is a downward deflection immediately preceding the ventricular contraction
- R is the peak of the ventricular contraction
- S is the downward deflection immediately after the ventricular contraction
- T is the recovery of the ventricles
- U is the successor of the T wave but it is small and not always observed

Also there are 10 electrodes used in 10-lead ECG that we can find normally.

- RA : On the right arm, avoiding thick muscle.
- LA : in the same location where RA was placed, but on the left arm.
- RL : On the right leg, lower and end of inner aspect of calf muscle.
- LL : same location with RL but left leg
- V1 : In the fourth intercostal space (between ribs 4 and 5) just to the right of the sternum (breastbone).
- V2 : In the fourth intercostal space (between ribs 4 and 5) just to the left of the sternum.
- V3 : Between leads V2 and V4.
- V4 : In the fifth intercostal space (between ribs 5 and 6) in the mid-clavicular line.
- V5 :Horizontally even with V_4, in the left anterior axillary line.
- V6 : Horizontally even with V_4 and V_5 in the mid-axillary line.

Position of V1 to V6 are shown in figure below.



https://www.cablesandsensors.eu/pages/12-lead-ecg-placement-guide-with-illustrations

Here is additional video related to 12-lead ECG connection.

https://youtu.be/HHCoSyKlPaE

Individual Contributions

Team Member	Contribution	Weekly Hrs	Total Hrs
Sovann	Began to research and write some rudimentary code to test iOS API and the Swift language	6	13
Justin	Began research on android application design and methodology	6	12
Omar	Began researching coupled inductors as a potential application for determining level of electrolytes in the human body.	6	12
Sungmin	Study one of the basic principle for	7	13

	health sensor such as ECG signal. Studying how its signal processing is working.		
Sangwon	Analysing signal from heart related to ECG. How many sensors and what position that ECG sensor placed normally.	7	14

Plans for Next Week

- (Sungmin, Sangwon, Omar) Check why we need to use 3D printer, and, in what kind of way, we will use 3D printer
- (Sungmin, Sangwon, Omar) What kind of health monitoring we will include of our sensor.
- (Sovann) Discuss in more depth with Dr. Dong in regards to the programming that may have to be done for the 3D printer.
- (Sovann) Write a testable application API which can be interfaced with a UI using Swift.
- (Sovann) Rent a bluetooth accessible device to play around with the bluetooth API for iOS.
- (Sangwon, Sungmin) research about how circuit looks like on today ECG sensors. How big, how to build, what components are used, average cost, and energy use.
- (Sangwon, Sungmin) research on technology about low power bluetooth technology.