EE / SE 491 Week 2 Status Report
Feb. 25, 2019 - Mar. 1, 2019
Group: sddec19-20
Project: Ultra-thin electronic skin for real-time health Monitoring
Advisor/Client: Liang Dong

Team Members:
Sovann Chak: Software Architect, iOS Developer
Omar El-Sherbiny: Circuit design and analysis of Sweat sensor
Justin Gordon: Software Developer, Communication research
Sungmin Kang: Circuit design and analysis of Mobility sensor
Sangwon Lee: Circuit design and analysis of ECG, DMD 3D printer

Passing Week's Accomplishments

Software Engineers

(Sovann)

- Various questions were answered by Dr. Dong in regards to testing and implementation
    - Stakeholder has provided us freedom in full design and has approved preliminary designs
    - My suspicions regarding each sensor containing its own bluetooth chip were correct - which may increase the total cost of the project
    - Stakeholder told me to research various testable tools from digikey.com
    - Bluetooth will be the main source of communication between the application and the ultra-thin wearable sensors
    - No programming in regards to printer - it will have to be put together and designs will be made in CAD
- Decided to use my personal raspberry pi 3 devices as testing tools to provide some longevity to our budget
    - Raspberry PI 3's are roughly $30
    - Have bluetooth built in
- I researched various tools and created a list of potential items to purchase assuming I get approval from our stakeholder
    - https://www.digikey.com/short/pqpr9f
    - The parts compiled are to be used with my personal raspberry pi 3 devices

- Began attempting to interface basic iOS API with the raspberry pi 3

(Justin)

- Asked questions to Dr. Dong and learned that Testing and implementation are largely left to the developers in case of this app
- Development of a second application
    - Research on the Android operating system
    - Integrating Bluetooth into the application with use of raspberry pis
- Assessed and approved parts list that Sovann had made up and got the go ahead from our client

Electrical Engineers

(Omar)

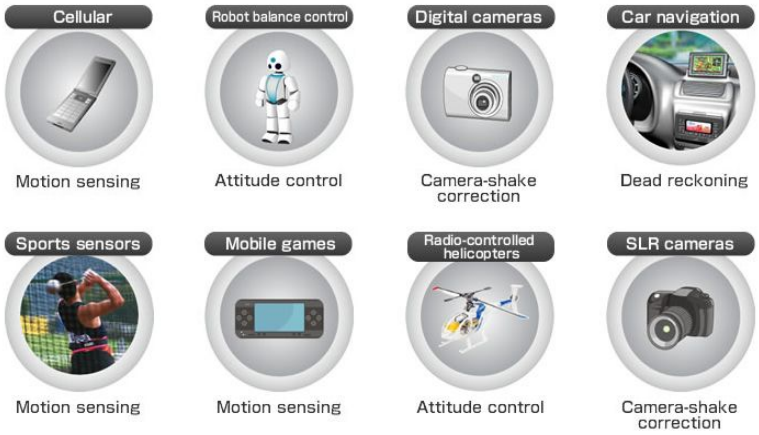
- Met with Qiang Li, a graduate researcher at the Laboratory for MEMS and Biochips, to explore possible manufacturing processes for the circuit boards.
    - First option proposed by Dr. Dong was to use a solid freeform device. The idea is to transfer the circuit board design to a digital micromirror device (DMD) and project light onto it. The device will reflect the light which will be focused through optical lenses to print the circuit board using a resin.
    - Several challenges arise with this fabrication method since this type of additive manufacturing, colloquially known as 3D printing, has not been developed before in the MEMS Lab, according to Li.
- The current DMD device in the lab has a protective glass layer to block UV light from damaging the array that includes millions of micromirrors. UV light is stronger than visible light and chances of having defects in the manufacturing process are lower.
    - Ultraviolet optical lenses that are to be used to focus the reflected light are extremely expensive. Prices for a single 5 cm lens falls between $2000-$3000, which appears to be a huge obstacle. This has yet to be discussed with the client, Dr. Dong.
    - Conversely, a visible light optical lens costs no more than $120; however, with visible light accuracy significantly falls down and other challenges like light aberration and astigmatism arise. The circuit size will be in the micrometer range, and accuracy is indispensable.

- The Department of Material Science has worked with several solid freeform devices, so borrowing optical lenses from there is a viable option that will be explored.

(Sungmin)

- Approached Gyro sensor for mobility sensor.

-There were many applications in Gyro sensor, and I focused on motion sensing like sports sensors for mobility sensor.



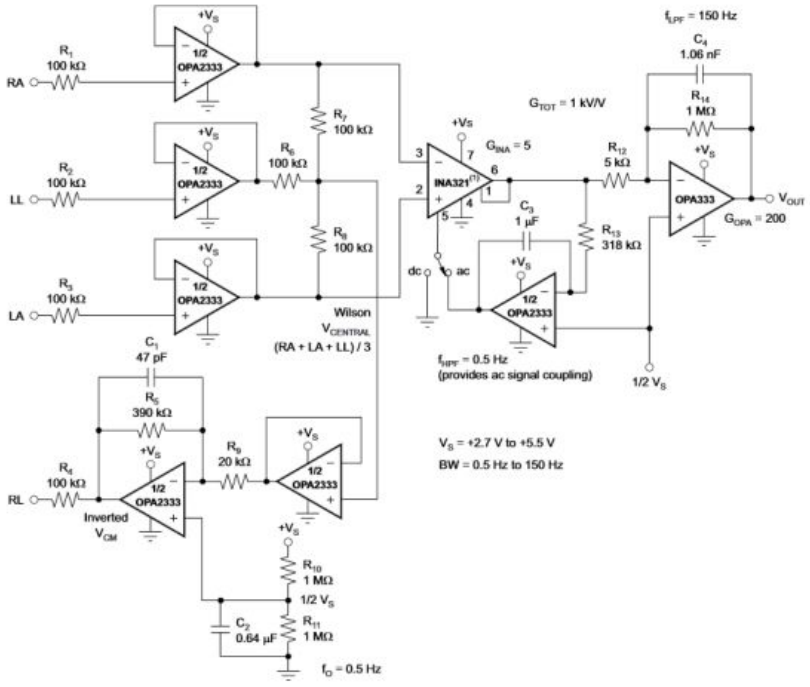
(https://www5.epsondevice.com/en/information/technical_info/gyro/)

- Check the basic principles of Gyro sensor focusing on angular measurement working. (https://learn.sparkfun.com/tutorials/gyroscope/all)
- I thought about flexible band for mobility sensor.

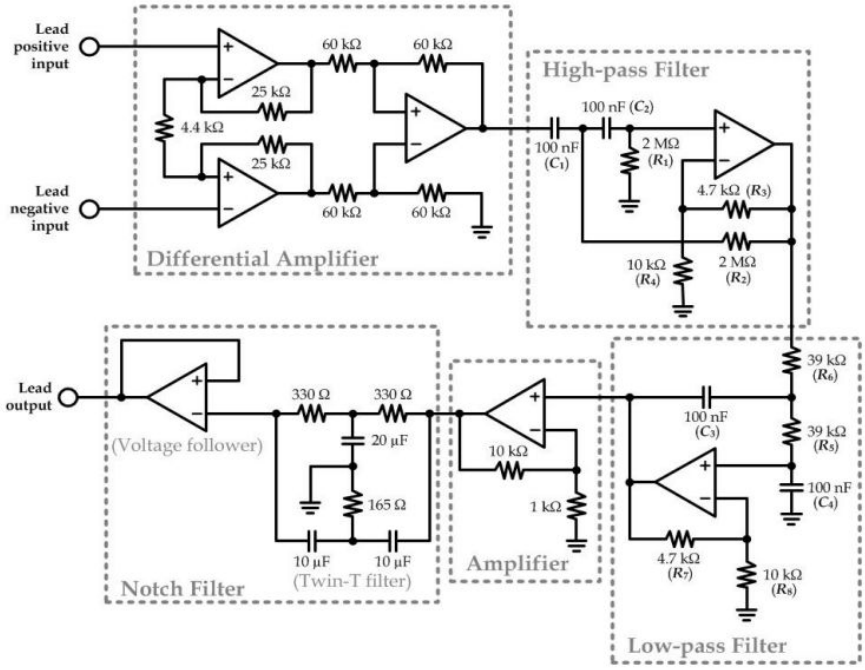
(https://www.sciencedirect.com/science/article/pii/S0921889014001821)

(Sangwon)

- Basic circuit diagrams and idea for ECG sensor.
    1. There are various type of ECG circuit diagram. Their basic principle is same but lots of design.
    2. Basic idea is lead → Differential Amplifier → High-pass Filter → Low-pass Filter → Amplifier → Notch filter



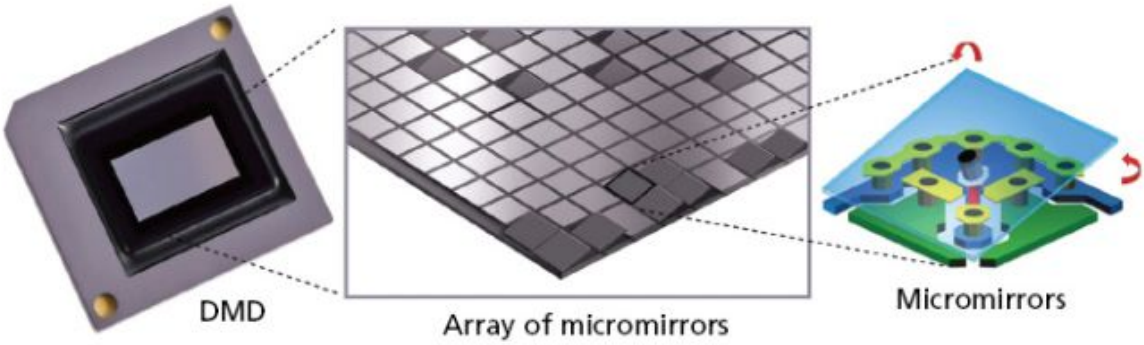
Inexpensive, Portable, SmartphoneBased 12-Lead Electrocardiogram



Hu, Dinglong & Kei Cheng, Tin & Xie, Kai & Lam, Raymond. (2015). Microengineered Conductive Elastomeric Electrodes for Long-Term Electrophysiological Measurements with Consistent Impedance under Stretch. Sensors. 15. 26906-26920. 10.3390/s151026906.

- Basic feature of DMD(Digital Micromirror Device)

- Consist of lots of array of micromirrors.
- Each micromirrors can move individually and that can control the way of reflecting direction.
- DMD 3D printer use DMD device and UV lights.



Individual Contributions

Team Member	Contribution	Weekly Hrs	Total Hrs
Sovann	Sketched out multiple designs of possible user interface and put together a context diagram to better trawl requirements from our stakeholder - we finally had a meaningful meeting about the software aspect of the project. Researched and compiled a list of parts to begin learning how to interface an iOS app with bluetooth and other sensors.	6	26
Justin	Created a list of questions regarding expectations of the application we will be developing. Finalized two different devices in which the app will be developed as well as the main component for the	6	25

	front end. Waiting on bluetooth parts in order to develop an interface with android operating systems.		
Omar	Explored manufacturing process including solid freeform devices, and standard semiconductor process. The solid freeform device comes with a lot of obstacles ranging from assembly to economic viability.	6	24
Sungmin	Targeting Gyro sensor as being used for mobility sensor. Check how Gyro sensor is used. Understanding basic principles of Gyro sensor which can apply to the mobility sensor. Focused on the aspect of measuring angle in Gyro sensor. In addition, searched about flexible and stretchable band for sensor.	6	26
Sangwon	Researching on ECG sensor especially on circuit diagrams and basic sources about ECG. Also research on DMD 3D printer. DMD device research and mechanism of Digital Micromirror Device.	6	26

Plans for Next Week

- (Sovann) Begin initial architecture designs now that I have a clear idea of the projects trajectory
- (Sovann) Order parts for the raspberry pi 3s and take care of the reimbursement process through our stakeholder
- (Sovann) Successful and reliable communication between iOS API and raspberry pi 3 bluetooth

- (Sungmin) Make sure whether it is possible to apply Gyro sensor in mobility sensor
- (Sungmin) Think about specific components for mobility sensor
- (Sungmin) Search the alternative way for mobility sensor (Not Gyro sensor)
- (Sungmin) Think about software to design mobility sensor

- (Justin) Further look into android development
- (Justin) Begin researching front end technology discussed
- (Justin) Get familiar with the technology that the raspberry pi uses

- (Sangwon) Further study on additional ECG circuit
- (Sangwon) Power need on ECG (low power)
- (Sangwon) Study for how to control micromirrors

- (Omar) Get in touch with the research group in the material science department to further explore options for the 3d-printer.
- (Omar) Start researching design and implementation strategies of a sweat sensor that measures cholesterol levels and electrolyte levels.
- (Omar) Start exploring the standard semiconductor manufacturing process to build the sensors.