EE / CprE / SE 491 – sdmay18-12

Pilot Biometrics - ECG Waveform Captures
Week 2 Report

1/26/2017 – 2/9/2018
Client: Rockwell Collins
Point of Contact: JR Spidell
Faculty Advisor: Dr. Tyagi

Team Members:

Ryan Gallus - Team Lead
Justin Bader - Filter Design Lead
Zachary Glanz - Filter Design Lead
Kory Gray - Operating Systems Lead
Andrew Jones - Algorithm Design Lead
David Kirpes - Circuit Design Lead

Weekly Summary

This week, our team made significant progress on project milestones. We determined what hardware filters will be needed, calculated frequency ranges and have completed preliminary designs for both a bandpass and bandstop filter. We also finished more work on the software filter for correcting random muscle contractions. Team members finished developing the power supply and tested with all components. Communication with the ADC has been established, which is able to read and write to the microcontroller board. We also finished more work on the main algorithm for analyzing the ECG waveform via a neural network.

Past Week Accomplishments

- Continued work on software and hardware filter design. Filter will account for several factors:
    - Baseline wander for low-frequency noise
        - Hardware high-pass filter at 0.05Hz
    - Interference from power source
        - Hardware bandstop filter for 50/60Hz frequency
    - Muscle noise correction
        - Software algorithm
    - Radio frequency noise
        - Hardware low-pass filter around 300Hz
- Working power supply constructed.

    - Prototyped. Contacting advisor to see if he would like us to build a PCB for it of if we should just leave it in a breadboard.
- Continued writing main algorithm.
    - Implementing a way for the user to customize size of the layers of the neural net
    - Added the logic to calculate weights and values of node as well as the sigmoid values of the nodes.
- ADC communication with microcontroller test board.
    - Learned and setup SPI interfacing with ADC (on test board). Able to change adc settings and read ECG data over wire.

Pending Issues

- Waiting for battery to arrive from client
    - Using a personal battery for testing and development until the part arrives
- New microcontroller board still unable to boot to Linux from memory
    - Attempts to reinstall linux every reboot
    - Using built in operating system on old board for testing and development now

Individual Contributions

Team Member	Contribution	Weekly Hours	Total Hours
Ryan Gallus	Continued research and development of filters for ECG signal processing. Determined need for both a bandpass and bandstop filters. Calculated frequency ranges for both filters. Bandpass will be used to filter baseline wander noise and high frequency radio interference, while bandstop filter will block powerline noise. Also continued development of software filter for detecting and handling random muscle contractions. Most ECG sensors correct this in software but algorithms are proprietary.	7	72
Justin Bader	Designed, simulated, and prototyped the power supply. Current supply has the ability to take an AC voltage from the wall and use a transformer to step the voltage down. Then the current iteration has 3 voltage regulators to power microcontroller and ADC but believe we can change it to 2 outputs as the microcontroller can supply two of the voltages. (Was then able to power microcontroller and ADC off of the prototyped power supply) Worked with Zach on communication with ADC. Able to setup communication with it over SPI. Currently can read/write to registers and read the voltage data coming in from ADC. Obtained a component to and begun work on wire harness to	12	50

	interface ECG sensors with ADC. Midway through script/program to allow easy interfacing with ADC without need of MMB0 companion board. Zach and I also worked briefly on the Linux install of the new microcontroller. Issues with it wanting to reinstall itself will look into more this week.		
Zachary Glanz	Worked with Bader to begin communication and setup with ADC. Further messing with microcontroller to facilitate interfacing with ADC.	9	75
Kory Gray	As I waited for the dongle to be shipped, I looked at the data sheet for the micro-controller to determine in what areas we can temporarily hold data as we retrieve and process it. After the dongle came I also looked into an error where the microcontroller wouldn't properly boot to linux.	5	63
Andrew Jones	Continued writing main algorithm. This involved implementing a way for the user to customize size of the layers of the neural net. Also added the logic to calculate weights and values of node as well as the sigmoid values of the nodes.	6	58
David Kirpes	Power supply is basically constructed. We are just waiting on one more voltage regulator. I will throw it on a board once all parts are here. We thought we could use a built-in hardware filters, but there may not be an available bandpass filter. I will construct one as well as a stopband filter for blocking out power supply frequency. Waiting for a battery, so we may just use a personal one until then.	8	67

Comments and Extended Discussion

- Resource for ECG signal processing: https://www.eetimes.com/document.asp?doc_id=1278571
- At review last semester we were asked if the BUS would be able to handle the data throughput. We are currently running our SPI bus at 1MHz, although we could go faster without running into timing issues. Just leaving it at this speed will force us to move our sampling rate from 32ksps to ~10ksps (11.1111111ksps to be exact) which should still be plenty to get an accurate image of what is going on in the heart.
- MMB0 companion board ultimately turned out unnecessary. Will not be needed to interface with ADC.

Plans for Coming Week

- Connect a battery to the power supply
    - Run both the ADC and microcontroller off of the battery and power supply

    - Alter power supply to accept DC voltage from battery rather than AC from wall
- Route ADC data from microcontroller registers
    - Currently able to read and write, need to access in software next
- Interface the ECG sensors with the ADC and into the microcontroller
    - All parts tested and working independently
    - Connect three ECG sensor leads to ADC
    - ADC writes to registers on the microcontroller
    - Software on the microcontroller reads data