EE/CprE/SE 492 Biweekly Status Reports 6 & 7

Dates Covered: 11/5/18– 12/3/18

Group #: 5

Project: Micro-Electro-Mechanical Systems (MEMS) Based Sensing System for Soil Conditions Monitoring

Client: Dr. Halil Ceylan

Advisor(s): Shuo Yang and Dr. Yang Zhang

Team Members:

Nathan Coonrod (Report Manager)

Kyle Kehoe (Communications Manager)

Jacob Verheyen (Meeting Facilitator)

David Severson (Web Master)

Sok Yan Poon (Timeline Manager)

Note: This report covers the work done over the course of about a month, hence the title of the report being Biweekly Status reports 6 & 7. This was done since the due date of one of the status reports fell on fall break. It was agreed upon by team members to just include two biweekly status reports into a single document.

Summary

Our DAQ system is nearing completion as we are currently in a testing phase and verifying the system is operating as intended. The final mechanical design of the system has been completed and all previous mechanical issues have been resolved. The DAQ PCB has its own custom enclosure made of delrin plastic and is able to mount directly to the top of the enclosure via four mountable thumb screws (see Figure 1 below). In addition the system has a slider power switch, two indicator LEDs, and two sensor channels that both can receive temperature and moisture data.

Figure 1: Fully assembled DAQ system mounted to custom enclosure.

Various hardware and software testing has been completed to verify system operation. These are summarized in table 1 below.

Name of Test	Description	Result
Battery Management Testing	Verify the battery management circuitry on DAQ is operating correctly.	Battery recharges when micro USB connection is made to laptop. Battery charging LED glows.
Battery Life	V = IR relationship used across 10 Ohm resistor to verify current draw when system is on.	Measured average current draw to be about 1.6 mA with final program running. ~67 days of battery life caclulated with 2.6 A*h battery.

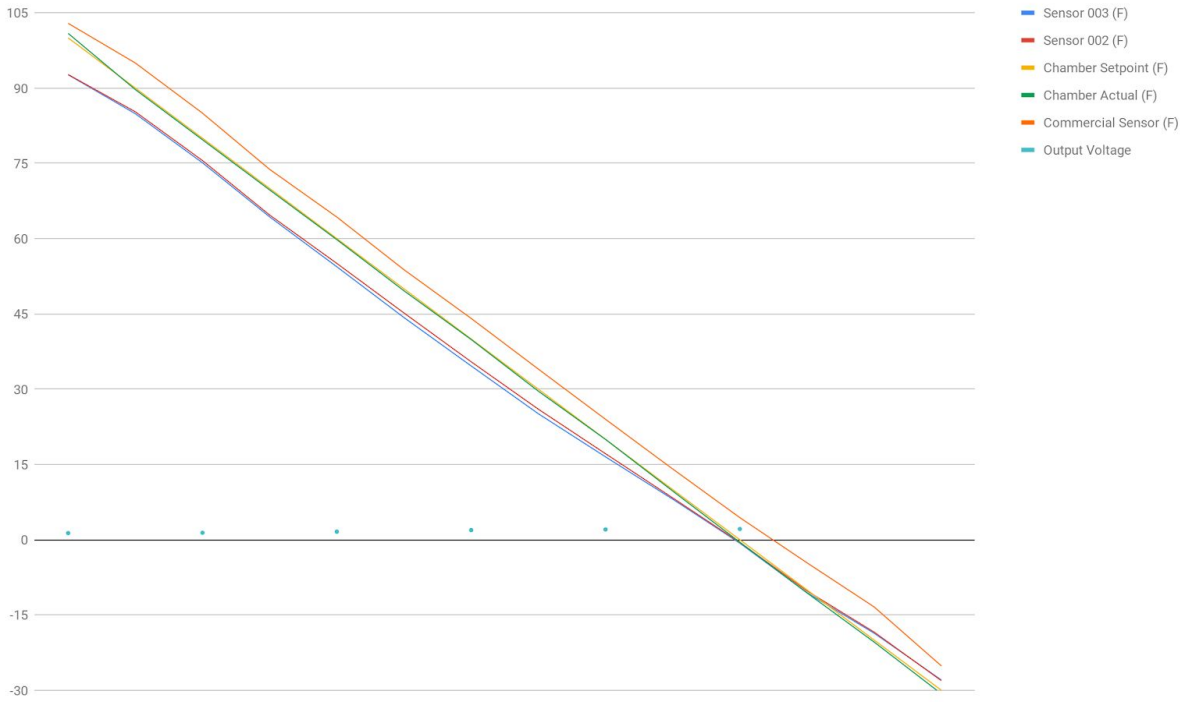
Microcontroller Sleep and Wakeup	Verify the microcontroller is able to be put to sleep and woken up by external alarm interrupt signal.	Using an oscilloscope and triggering function verified that RTC output dropped low and reset high after short time period one channel. Power draw increased for short time period as well (verified using differential probe technique.) See Figure 2 below.
Data Collection	Verify the SD card is having data written to it, and these data values are written line-by-line in CSV format.	Letting program run for a short amount of time (~5 minutes) and manually setting short sample period of 1 minute verified that 5 accurately timestamped data values were recorded.

Table 1: Summary of important tests and their results.

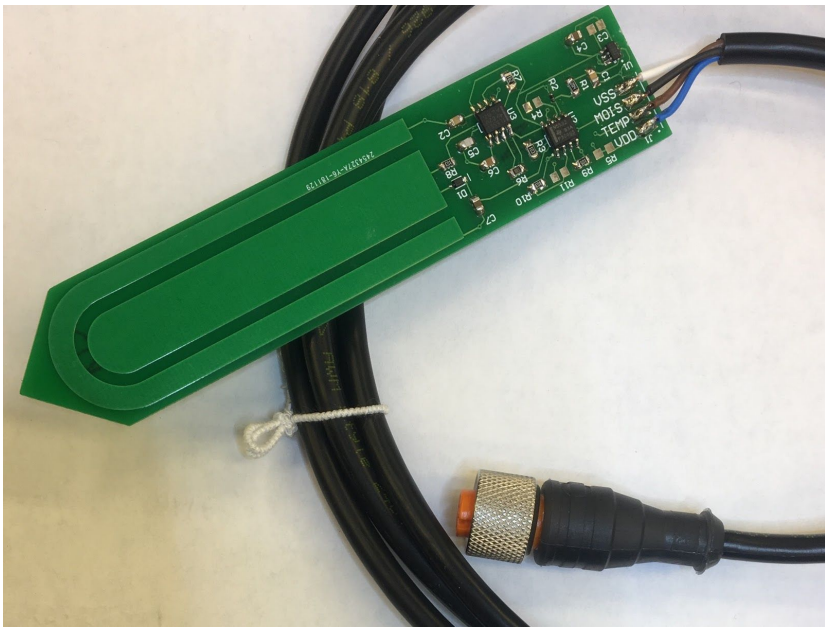
Figure 2: Oscilloscope screen shot for sleep and wakeup test. The blue waveform is monitoring the interrupt signal generator output of our real time clock IC. The pink waveform is a differential probe signal across a resistor which can then be used to measure a current draw and obtain power used by the system. Note that when the system wakes up (when the blue signal goes low) the current draw is not constant and is only for a short time period (~11.6 ms).

Sensor testing and characterization

Original temperature sensors were tested for functionality by use of a temperature chamber and a commercial sensor for verification. We took steps in increments of 10 degrees fahrenheit and observed the temperature reading of the chamber, the commercial sensor, and the voltage of our created sensors (converted voltage into temperature through an equation). In this chart we can see the temperature our sensor is measuring, the temperature the commercial sensor is measuring, and the temperature the heat chamber is measuring. The heat chamber has the largest error, so the commercial sensor is what we will use to calibrate our temperature sensor.



The temperature testing went very well, and we ended up receiving and building our new sensors as well. The new sensors have been soldered to the cables that will connect to the data acquisitions module.



This image shows the new sensors that are completely build. The temperature circuit is identical to the sensor we had characterized in the temperature chamber. This new sensor will also have the ability to measure moisture content of soil by capacitance measurement. The circuitry on this sensor will eventually be coated in an epoxy to protect it from the elements. We created four of these sensors per our requirement from our client.

Accomplishments

- Kyle: Assisted with DAQ hardware testing and debugging including power draw, LDO dropout voltage, etc. Also helped with developing code to implement putting the microcontroller to sleep, waking up from sleep via interrupt, and time-stamped data-logging.
- Nathan: Finalized DAQ hardware debugging including input buffer issues and analog reference issues. Implemented sleep and interrupt software with Kyle and integrated into existing DAQ software. Power consumption testing and general testing of system performance.
- Jacob: Finished designing and ordered new sensors. Characterized temperature sensors.
- David: Tested sensors in temperature chamber. Soldered new sensors and completed testing on the new sensors as well. Will continue to test new sensors in order to characterize them.

- Sok Yan: Assisted with working on final poster and final report. Helped review all the code that are implementing to microcontroller.

Pending Issues and Tasks In Progress

Our sensor PCB design that includes moisture capacitive circuitry arrived on 12/3/18. Depending on whether time allows we would like to characterize the temperature and moisture sensor circuitry for the new sensors and include in the software for the DAQ, so they can properly integrate. If this is not feasible, we intend to inject test voltages and demonstrate that our DAQ is able to measure those well since temperature is an indirect measurement obtained as a function of the measured voltage on a sensor channel.

Individual Contributions

Name	Contribution	Hours This Month	Hours Cumulative
Kyle	Hardware testing, software development, testing, and debugging. Poster layout/design.	20	55.5
Nathan	Hardware debugging, testing, software testing, administrative tasks	20	58
Jacob	Sensor design, testing, characterization	20	56
David	Sensor testing and soldering. Sensor characterization	18	52
Sok Yan	Review code implementing to microcontroller, and helped working on documentation	18	53.5

Plan for Coming Weeks (12/3/18 - 12/14/18)

As a team we will be preparing final documentation and presentation slides for our final presentation on 12/6/18. In addition, we will be scheduling a brief meeting to hand off our project deliverables and borrowed equipment sometime during finals week (12/10/18 - 12/14/18). The time for aforementioned meeting during finals week is TBD.