EE/CprE/SE 492 Biweekly Status Report 4

Dates: 10/8/18 – 10/22/18

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)

Summary

Our team has been working on characterizing our sensors to be able to write appropriate software that can implement the moisture and temperature measurements and data collection. Specifically, on 10/11/18, our team attempted moisture characterization of our sensors with the help and assistance of team adviser Shuo Yang in the PCC Lab in Town Engineering Building. Most of our setup is shown below in Figure 1. A 3.3V power supply was used to power one of our sensors and a handheld multimeter to obtain output voltage readings from the sensor. Figure 2 shows the complete setup with our sensor submerged within sand in a plastic bag.

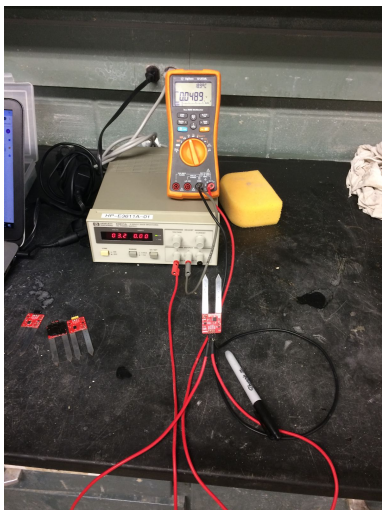

Figure 1: Base setup for moisture characterization.

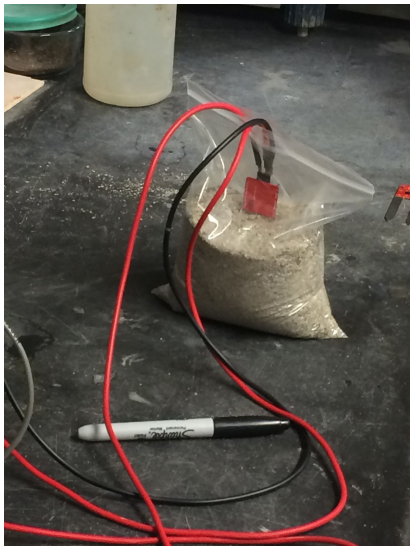

Figure 2: Moisture sensor submerged in sand inside plastic bag.

Unfortunately with our setup, we found that the output voltage reading we obtained from the sensor was constantly changing and didn't seem to settle to a single value in an appropriate amount of time. Other sensors were tested as well to observe this same behavior. In addition, we tried obtaining a moisture measurement from topsoil instead of sand in the below setup shown in Figure 3. This specific setup was allowed to run overnight to see if by the next morning a steady resistance value could be obtained from the topsoil. Unfortunately we saw a continually increasing resistance value from approximately 45 kOhms to 82 kOhms over a 12 hour period. This increase in resistance was not linear but increased faster in the first couple of hours and then increased at a decreasing rate the remaining time. With these measurements not settling it was impossible to obtain raw data for different moisture content levels.

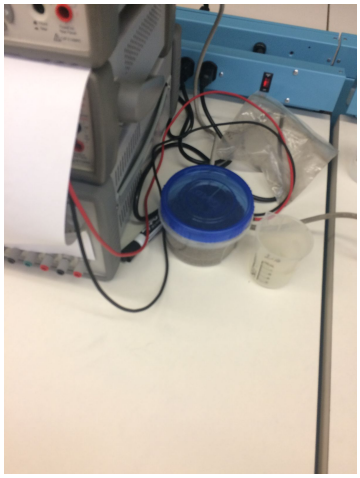

Figure 3: Setup of moisture characterization in topsoil.

Accomplishments

- Kyle: Worked on software related items and got the low interrupt to wake the microcontroller from sleep mode properly. Also started writing skeleton code for taking the actual temperature and moisture measurements and properly check if the SD card is present. Assisted team with continued efforts on moisture characterization of sensor.
- Nathan: Moisture sensor characterization, testing of capacitive sensor prototype. DAQ software help, ordered DAQ PCB and generated BOM for parts order.
- Jacob: Helped with moisture sensor characterization.
- David: Used epoxy to protect sensor circuits. Baked soil for moisture characterization. Began testing moisture sensor - found issue using our method.
- Sok Yan: Assisted team with characterizing moisture sensor and worked on software development.

Pending Issues

After much thought and continued efforts with moisture characterization, we found it incredibly difficult to find a way to measure a stable resistance/voltage value across the probes on our sensor. We spoke with Dr. Tuttle in the EE department to see if he had any suggestions on how to troubleshoot and proceed with this issue affecting our sensors. He told us that it may be more of an underlying physics problem at play, i.e., there is a lot of variation caused by the soil medium itself that moving electrons (current) don't consistently take the same path when a resistance measurement is being taken. If we were to try to continue with our same approach of measuring soil moisture content by a resistance based sensor, an averaging algorithm would have to be developed. Our team is of the opinion that a redesign of the moisture measurement circuitry should be done to address this issue of resistance changing too quickly. Instead of using a resistance based sensor for moisture, we will instead implement a capacitance based sensor. Preliminary observations made in the lab indicate that capacitance measured across our probes is much more stable, i.e., not changing, than the resistance measurements we attempted to make earlier and the measured capacitance is also sensitive to an increase in moisture content of soil.

Individual Contributions

Name	Contribution	Hours This Week	Hours Cumulative
Kyle	Software development and moisture characterization.	8	27.5
Nathan	Moisture sensor characterization	7	28
Jacob	Moisture sensor characterization.	8	28

David	Moisture sensor characterization. Soil prep, epoxy-ing sensors	7	27
Sok Yan	Moisture sensor characterization and software development	8	27.5

Plan for Coming Weeks (10/22/18 – 11/5/18)

- Kyle: Help with redesign of moisture sensor, assemble DAQ PCBs, and continue software development.
- Nathan: Assemble DAQ, continue software development, help with capacitive sensor redesign
- Jacob: Help with redesign of moisture sensor, assemble and test DAQ PCBs.
- David: Soil preparation, soil sensor protection, moisture sensor testing.
- Sok Yan: Continue software development.