sdmay18-38: Smart Wireless Ag Sensors for Measurement of Soil Water Contents

Week 4 Report
October 12 - October 17

Team Members

Colin Cox — *Software*
Wage Miller — *Hardware - Control Box*
Jarrod Droll — *Hardware - Sensors*
Rachel Hoke — *Hardware - Sensors*
Scott Rowekamp — *Software*
Tyler Thumma — *Hardware - Control Box*

Summary of Progress this Report

Our group was split into 3 groups:
1) Sensors (Jarrod/Rachel)
2) Application/Software (Colin/Scott)
3) Control Box (Tyler/Wage)

A) After meeting with our faculty advisor, we created a new design for the in-soil sensors. The new design changes the copper rectangular contact pads into a circular design. This design eliminates "the step up" from the PCB substrate to the copper pad. Errors can occur in this "step up" when silver is deposited on our PCB. Our new design in also wafer shaped rather than the older rectangular shape. The circular shape allows the PCB to fit better in the silver deposition machine. We plan on either applying a glue or shadow mask between the working and reference electrode to eliminate the "step up" problem. We created this design in AutoCAD and currently in the process of making Gerber files in order to have the PCB printed.

B) Now that we know the fabrication process for the sensors we met with a Ph.D. student this week to go over the measurements used to make the chemicals that are going to go on the sensors working and reference electrodes. Combining these steps we can start work on developing improved sensors for our project.

C) To gain a better understanding of how these boards and wafers are created we received training and background on the milling machine the ETG department. We learned that the machine isn't as precise as we had thought early and is also very fidgety due to the number of users and wearable parts the machine has. Additionally, we began analyzing the circuit design of our control box, as we were just given access to past designs.

Pending Issues

A) One of the pending issues for the in-soil sensors is converting our AutoCAD design into suitable Gerber files. Another issue we may face is the circular structure of our new design. The mill used to fabricate the PCB may not be able to make the cuts required for this shape.

B) Another pending issue is for mixing the chemicals for the Ion selective membrane (ISM) because it is a more complicated process than some of the other chemicals and is more expensive if you mess up the process. To fix this issue we are waiting to hear back from a Ph.D. student who is helping develop a more concrete method

C) The Grad Student in charge of the control box isn't back in the US. We were however given access to a box containing random parts and a few circuit diagrams for a previous design of the op-amp board. Another

challenging aspect to this is our client/advisor can't answer many questions about this, so we may have to do a lot of rework when she is back to meet her requirements.

Plans for Upcoming Reporting Period

A) We plan on creating Gerber files from our AutoCAD design and altering the circular design into an octagonal shape so that we can fabricate our sensors in-house. We also plan on looking into having our PCBs created through an online vendor.

B) We also plan on starting in on creating the chemicals that we need to use throughout the fabrication process now that we have the process and the amounts needed. We will be starting with the easier ones like PVC for the reference electrode and PEDOT for the working electrode.

C) Further analyze the behavior of the control box circuit using PSPICE and other circuit software. Look for a control box that meets the requirement of ¼ the size of the current control box. Communicate with undergrad student when she returns in order to finalize circuit design.

Individual Contributions

Team Member	Contribution	Weekly Hours	Total Hours
Colin Cox	Started to develop applications for the microcontroller, coordinator, and tested software on development boards. We as a group also received additional training on the mill from the grad student who created the first design of the sensor board.	4	17
Wage Miller	Built circuit diagram in PSPICE based on technical circuit documents found of previous design of the board. Began tinkering with i/o of the circuit to see how it functions.	3	16
Jarrod Droll	Met with our faculty advisor to determine an improved design of our in-soil sensors. Created a 3D model of our proposed in-soil sensor design as well as created a 3D model of the wafer shaped sensor PCB board.	4	17
Rachel Hoke	Met with PhD student to go more in depth on the chemical makeup of the solutions that need to be made for the sensors. Getting information on the various weights and measurements for making ISM, PEDOT, and PVC Also communicated and set up various meetings throughout the week.	3.5	17.5
Scott Rowekamp	Went over the current microcontroller	3	15.5

	designs to determine how it works now, and what we will need to change in order to make it smaller and easier to interface with.		
Tyler Thumma	Built our sensor circuit on PSpice based off of the technical documentation provided to us. Started looking at how we can re-design the circuit to fit the requirement of ¼ of the size.	3	12.5