EE/CprE/SE 491 WEEKLY REPORT 8

10/25/2024 – 10/31/2024
Group number: sdmay25-04
Project title: Wireless Mesh Network for Pesticide Spray Monitoring and Mapping

Client: Claussen Lab- Iowa State University

Advisor: Nathan Niehart

Team Members/Role:

Software Team

- **Ashley Falcon:** IDEs and Microcontrollers, Group Communicator
- **Drew Scheidler:** Mesh Networking; Note Taker
- **Henry Hingst:** Mesh Networking; Group Leader

Hardware Team

- **Hector Perez Prieto:** Microcontroller; Circuit Design and Testing
- **Yok Quan Ong:** Circuit Design and testing; Microcontroller
- **Wesley Smith:** Circuit Design/Simulation; Microcontrollers; Note Taker

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Weekly Summary

- **Hardware Team**
  - Ran simulation on voltage regulators and voltage inverters
    - Voltage boost converter providing a step up voltage to 5V
    - Voltage inverter providing inverted voltage of -5V
    - Read datasheets and created according to circuits
    - Ensured they worked in simulation in conjunction with our circuit
  - Found necessary batteries and chargers for future circuit building
    - 3.7V sources
  - Analyzed our sensor reading circuits worst-case simulation and decided it wasn’t what we wanted
    - In the past, we had thought it was a fine range of error
    - Our advisor suggested it was not; this forced us to begin re-starting our plan going forward
- **Software Team**
  - Started programming the microcontroller to output data to the SD card
    - Set up code to initialize the SD card and determine if it is ready to receive data

            - Currently debugging initialization code
        - Determined using SPI rather than SDIO was more efficient
            - Code is more streamlined and easier to adapt to SD card reader
        - Will feed a dummy text file to the card to ensure it is collecting data
    - Set up the circuit for the SD card
        - Connected wires between microcontroller outputs and SD inputs
            - Required soldering of SD card reader to pins
        - Scoured datasheet to determine which GPIO outputs should be used
        - Determined what inputs meant on SD card
            - MISO: Master-In Slave-Out
            - MOSI: Master-Out Slave-In
            - CS: Chip select
            - SCK: SPI clock
    - Successfully tested and set up the wifi mesh network provided by Espressif
        - Initial setup is complete and successful
        - The nodes successfully send heartbeat messages to each other, updating the mesh network's status and structure
    - Successfully tested an example provided by Espressif of board-to-board 802.11LR mode communication
        - Example is a console based control of the ESP32 board that allows the sending and receiving of wifi packets using the 802.11LR mode (also called 802.15.4 by Espressif)

<u>Past week accomplishments</u>

- **Ashley Falcon:**
    - Looked in APIs provided by Espressif to program SD card reader
        - Tried to initialize the card
            - Currently troubleshooting
        - Determined a SPI bus is far more straightforward than SDIO
        - Opened a file and wrote to it on a local device to ensure it was working
    - Scanned microcontroller datasheet
        - Found information regarding which GPIOs are most suitable for SD connections
        - Determined how to set pins
    - Collaborated with HW to determine was ratio should be used when converting from mV back to resistance
- **Drew Scheidler:**
    - Setup environments in Windows

  - Synced working projects with Git
    - Created testing branches and component branches for code
  - Experimented with SD card component
    - Setup circuit with SD card and MC and connections between the two
      - Ran tests on circuit setup
    - Looked into SD card and MC pinout
    - Looked into SD card documentation
    - Analyzed example code from Espressif and existing Arduino code
  - Researched MC ADC reference voltages and attenuation
- **Hector Perez Prieto:**
  - Researched Diodes to add to add to our circuit
    - Not yet successful but have researched and should be able to get it to function with our current circuit
  - Redesigning our current circuit to avoid worst-case scenarios (voltage is too high and will most likely give us inaccurate results)
    - Worked on recalculating and simulating circuit components
  - Tested resistances to get the output voltage to find a ratio that can be used by the ADC to convert voltages to resistance values

- **Henry Hingst:**
  - Successfully tested and set up the wifi mesh network provided by Espressif
    - Initial setup is complete and successful
    - The nodes successfully send heartbeat messages to each other, updating the mesh network's status and structure
  - Successfully tested an example provided by Espressif of board-to-board 802.11LR mode communication
    - Example is a console based control of the ESP32 board that allows the sending and receiving of wifi packets using the 802.11LR mode (also called 802.15.4 by Espressif)
- **Yok Quan Ong:**
  - Run worst-case analysis
    - Changed the op-amp that is used and run again.
    - We didn't get the output we were supposed to get.
  - Researched about the SD card circuit/ ESP32 circuit
    - Look into the SD card circuit and how to connect with the ESP32
    - Looked into the overall circuit between the Wheatstone bridge to ESP32 and SD card
- **Wesley Smith:**

    - Simulated voltage regulators that I had chosen last week
        - Identified a voltage regulator that would step a 3.7V battery up to 5V for our sensor reading circuit.
        - Identified a voltage converter that will provide a -5V source for our circuit.
        - Simulated them in conjunction with our old Wheatstone bridge and made sure it all worked according to our project goals
    - Found batteries and battery chargers I recommend us using
        - 3.7V sources to be stepped up to 5V

NAME	**Individual Contributions**	**Hours this week**	**Cumulative Hours**
Ashley Falcon	SD card initialization and programming	**7**	**45**
Drew Scheidler	SD card component and ADC research	**7**	**48**
Hector Perez Prieto	Circuit redesign and circuit calculations	**7**	**47**
Henry Hingst	Mesh wifi and 802.15.4 testing	**8**	**50**
Yok Quan Ong	Looked into the connection between SD card to ESP	**6**	**44**
Wesley Smith	Voltage regulator simulation/Battery research	**6**	**48**

Plans for the upcoming week

- **Hardware Team**
    - Redesign the Wheatstone bridge
        - Include calculation, simulation, and worst-case analysis
        - balanced Wheatstone bridge
        - Add a potentiometer at a branch of Wheatstone Bridge to check for error
    - Attenuate input voltage with 6dB
        - Increase ADC reference voltage
    - Find the smallest change in resistance value we can get
    - Run the worst-case simulation, and the bridge resistor doesn't have a variation or 0.01%
        - Observe the output range
- **Software Team**
    - Continue troubleshooting SD card initialization
    - Look into SD card documentation

- Specifically, look into Adafruit library to format SD card
- Will utilize FATFs module to create consistent file structure
  - Research application and big picture concepts
  - Use disk.io and file.h library
- Successfully write to and pull data file from the SD card
- Begin looking into ADC voltage conversions to resistance
  - Explore how we will feed ADC data to SD card and eventually other microcontrollers via mesh network
- Figure out how to send data packets over the mesh wifi network
- Set up the mesh wifi framework to use 802.15.4 instead of the standard wifi (802.11)

Summary of weekly advisor meeting

- Professor Neihart provided feedback on both the hardware and software teams.
- Hardware:
  - Redesign the Wheatstone Bridge
  - Show the calculations and simulation results
  - Connect ±5 to the top and bottom of the Wheatstone bridge
  - Balanced the Wheatstone bridge
  - Aim for the output range of 0.1V to 1V
  - Plot difference bridge resistance in MATLAB
  - Increase ADC reference voltage
  - Find the smallest change in resistance values we can detect
- Software:
  - Suggested we take advantage of Adafruit (SD card) libraries
  - Emphasized the need to understand the computer architecture big picture
    - Understand FATFs file structure
    - Initialize disk.io
    - Familiarize ourselves with using MMC/SDC
  - Rewrite the program for SD card
    - Currently, it is not working and is not coherent
    - We should utilize example code from Espressif
  - Provided resources for better understanding SD card interaction with the microcontroller itself