EE/CprE/SE 492 STATUS REPORT 05
3/14/25 – 4/3/25

number: ***sdmay25-17***

Project title: ***Microbial Pill Sensor***

Client &/Advisor: ***Dr. Meng Lu***

Team Members/Role:
Roles still subject to change as we transition from research to design phase.

- ***Wes Ryley:*** Data Transmission Design Lead
- ***Rakesh Penmetsa:*** Bacteria Housing Design Lead
- ***Alex Upah:*** Biosensor Design Lead
- ***Cade Kuennen:*** PCB Design Lead

Weekly Summary

Our team continued to work on completing their individual project tasks including sending updated housing design to ETG for CNC, continued development of GUI code functionality, and PCB building, testing, and troubleshooting. Major progress has been made in regard to the OPT PCB as the team has been able to verify the functionality of the PD and LED chosen for this project. Although there were issues with the amplifier circuit on the OPT PCB, the team was able to work together to identify the issue (detailed below) and try to come up with ways to fix it as well as ways to continue with testing while not having the working amplifier on board. The team also worked on creating a response curve for our Photodiode by shining light into the PD from the ESP32C3 Dev Kit at different light wavelengths, brightnesses, and with or without the filter (see collected data below).

Past week accomplishments

Team:

- Alex and Wes made a makeshift testing environment using photodetector and programmable LED. Measured dark response of photodetector, response when hit with blue light and response when hit with green light from programmable LED. Also tested response with inclusion of the filter. Data was recorded for discussion with Dr. Lu at the team meeting.

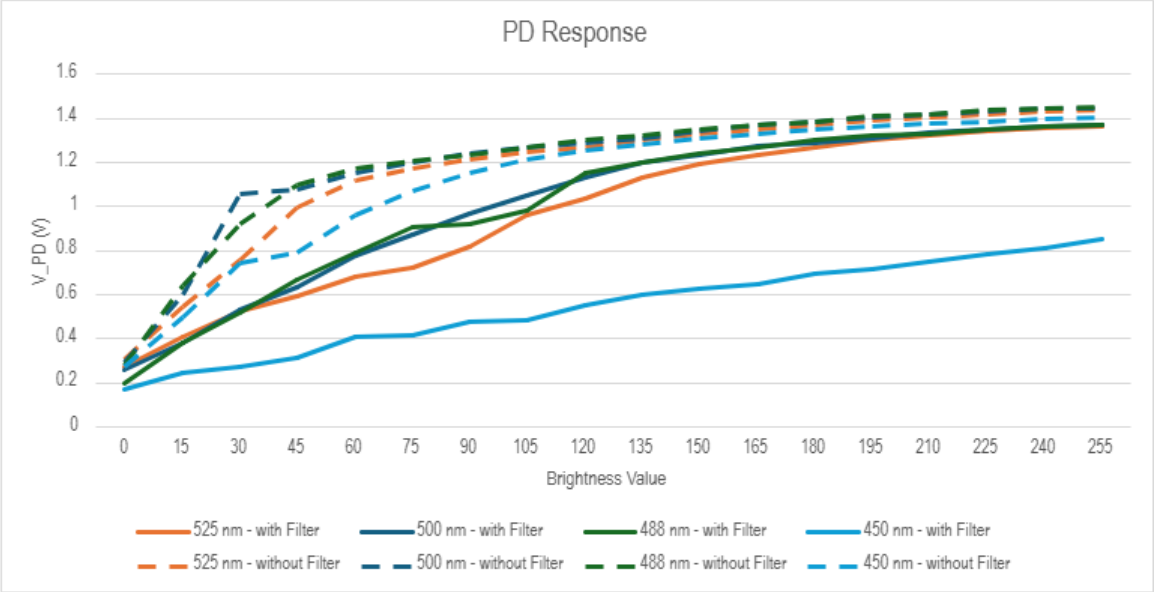
Cade Kuennen:

- Resoldered OPT PCB with surface mount components for easier testing with Alex. Was able to get power to the PCB but started seeing the output of our LM324 amplifier clip at 2V with .35V input from Photodiode.
    - Need to conduct testing on breadboard prototype to determine response of photodiode in dark enclosure to determine amount of power Op Amp will need to be supplied with.
    - Verified Photodiode is operational, although operating at unexpected values

        - Photodiode used on breadboard prototype produces a much smaller voltage than the PD chosen for final design implementation.
        - Ordered more EOPD-525-1-0.9-1 Photodiodes to have on stand-by during testing as these PDs can be burnt out easily during soldering.
    - Verified programmable LED is operational and can be controlled by MCU with Wes:
        - Was able to get stand-alone LED to follow behavior from same LED used in the ESP32-C3 Dev Kit on our breadboard prototype.
- Was given components needed to build TEST MCU PCBs Mon 3/24. Used these parts along with stencils ordered with PCB to reflow components onto board with reflow oven in the senior design lab:
    - Learned how to use solder paste and stencils as well as operate the Madell MD-2012 reflow oven.
    - Used microscope to determine the quality of connections made by reflow over:
        - Needed to do hand soldering work to fix shorts between pads of a few components to ensure operation.
    - Tested power delivery and continuity on TEST MCU PCBs.
- Brainstormed alternative housing designs with Rakesh to better fulfil project needs:
    - Moved location of USB input from bottom to side for ease of use during testing.
    - Needed to increase diameter of OPT PCB holder such that it can securely hold PCB in place.
    - Needed another hole to be drilled in OPT PCB holder to allow LED light to pass through to the microbe housing chamber.
- Set up makeshift system to test PD response from LED on MCU dev kit. Recorded values for PD voltage as a function of LED brightness and wavelength
    - Assisted Alex in developing test code while building makeshift testing rig.

Alex Upah:

- Helped Cade solder and test optical pcb board. Fixed issue surrounding inability to get power to the board but found issue in the op amp on board clipping at voltages lower than expected.
- Mapped clipping value to supply voltage of op amp. Testing will be done to determine what typical response voltages across the photodetector will be for actual setup, which will determine what solution is best for the op amp clipping issue.
- Determined response of photodiode in room light, dark environment, and when directly being hit by both green and blue light from programmable LED. The ambient light voltage produced by photodiode is higher than expected, which is causing the unexpected issue with clipping on the op amp.
- Set up makeshift system to test PD response from LED on MCU dev kit. Recorded values for PD voltage as a function of LED brightness and wavelength. Developed code in ardunio ide to perform this test.



Wes Ryley:

- Finished developing the Data Collection Cell code in Google Colab:
    - This python script runs in a single cell in Google Colab and allows for a user to select the type of data collection, either User Input or ESP32 Data, select the time interval that the data will be collected and exported to a Google Sheets log.
- Finished developing the Graph Creation and Update program:
    - This python script runs in a separate cell in Google Colab and allows for a user to create a graph based on the data that has been logged in Google Sheets. The graph will plot a data point at the specific value that is stored on the y-axis and will show the time the data was recorded at on the x-axis.
- Developed an Arduino IDE program that will run the test scenario for operation testing:
    - This program operates similar to the previous program except adds the addition of an external RGB LED that has been used to model both the Blue excitation LED and the Green response from the fluorescence proteins or fluorescent beads for lab testing.

Rakesh Penmetsa:

- Finished updating the dimensions cell housing design and submitted design for CNC:
    - Based on the drawbacks of the CNC designed cell housing, the design was updated on dimensions and modifying the diagram.
    - Based on the orientation change in the MCU cell. The MCU cell housing is redesigned.
    - Designed the detachable Battery cell housing and submitted the design to ETG for getting the CNC modeled Housing.

Pending issues

Team:

- OP AMP on pcb board is clipping before hitting our rail values. This leads to saturation of output voltage even when voltage across the photodetector increases, which inhibits the

ability of the device to sense changes in voltage. Update to design to account for this is likely necessary.

- When testing the photodetector response with the filter, we found that the voltage from the blue light was still higher than the voltage produced by the green light. The filter should reduce the blue light intensity, which it is not currently doing in makeshift system setup. Further discussion and exploration of why this is occurring is required.

Cade Kuennen:

- Need to add missing 2nH inductor to TEST MCU PCB when components come in before we can start testing and ensuring operation.

Alex Upah:

- Need access to complete housing design and equipment in LED to continue carrying out testing.
- The ADC on the OP AMP is not correctly reading the value of OP AMP output
- Arduino ide runs into serial USB connection error when trying to write to MCU from my personal laptop. Working on a solution but all listed options online have not worked so far. Not a crucial issue since it works on both Cade's and Wes's laptop.

Wes Ryley:

- The Serial input for Google Colab is extremely complicated since the program is a cloud-based environment. However, a document was found that contains code which should be able to connect the ESP32 device to the program as well as allow for active communication between the devices to allow a user to determine the ESP32 operation without having to push new coding over.

Rakesh Penmetsa:

- Waiting for physical cell housing from ETG.
- Cross checking the dimensions of the cell housing with the physical design and do different testing on it.

Individual contributions

NAME	Individual Contributions	Hours this week	HOURS cumulative
Cade Kuennen	Resoldered OPT PCB. Continued testing on OPT PCB. Verified operation of PD and LED. Troubleshoot issues regarding Op Amp operation. Built and reflowed TEST MCU PCBs. Fixed soldering issues from reflow of TEST MCU PCB. Created makeshift testing rig for testing PD response. Helped Alex develop test script for PD response testing.	19	59
Alex Upah	Helped with soldering and testing of optics PCB. Determined issues regarding OP AMP on board and tested values. Tested response of PD on board. Tested ability to control programmable LED separate from the MCU dev kit. Developed makeshift testing system for PD with MCU dev kit. Developed a script for testing different brightness levels and recording teh response.	18	42
Wes Ryley	Finished developing the Google Colab operations. Graph creation and updating has been successful and data collection and storage has been successful. Developed the MCU program which is being used during testing.	22	52
Rakesh Penmetsa	Finished updating the dimensions cell housing design based on the drawbacks of the previous design. And designed cell housing for the Battery and Updated the orientation of MCU. And made design with airtight housing for the demo. And submitted the design to ETG for the to get it CNC made.	15	44

Plans for the upcoming week

Team:

- Complete testing with OPT PCB in housing:
    - Use fluorescence beads to simulate microbe response in system.
    - Contingent on Rakesh new design working as intended.

Cade Kuennen:

- Run tests on TEST MCU PCBs to ensure code from ESP32 Dev Kit prototype can run on TEST MCU PCBs with Wes once components are in.
- Continue testing on OPT PCB and finalize solution for clipping amplifier with Alex.
- Resolder complete OPT PCB with all components and fixes in preparation for testing with CNC housing and fluorescence beads.

Alex Upah:

- Access light intensity measurement equipment from Dr. Lu's lab to convert LED brightness values to light intensity values.
- Use this information with current plot to compute sensitivity of PD to light intensity.
- Plan to carry out testing with optical system with fluorescent beads provided by Dr. Lu

Wes Ryley:

- Develop the Serial connection between the MCU and Google Colab as well as create live interaction for changing the operation of the MCU without the need for pushing more updated code.
- Assist in testing if new code needs to be developed for the MCU operation.

Rakesh Penmetsa:

- To Test the cell housing in water to confirm that it is airtight. To assemble the components in the cell housing. If there is any change in dimensions update the cell housing design and get the updated CNC model
- After the testing, need to make the same cell housing using opaque material for testing the optical sensor.

Summary of weekly advisor meeting

Advisory Meeting 3/26:

- Communicated issues with amplifier circuit to Dr. Lu:
    - Was given advice to isolate the amplifier circuit and run tests on that using expected PD voltage values
- Walked though Rakesh housing design with Dr. Lu:
    - Will need to use some sort of black paint on OPT PCB housing mechanism that can block LED light from influencing photodetector readings
    - Don’t need to worry about waterproof ability of USB connected housing
        - Rakesh to create alternative housing design that is more representative of final product that waterproof testing could be conducted on.

Advisory Meeting 4/2:

- Discussed the new developments in testing and code development to Dr. Lu:
    - Demonstrated the system's operation and expressed the new knowledge which has been learned through the testing. Shared concerns over the saturation of Op-Amp rails which is affecting the data collection.
    - Demonstrated the Google Colab operation and how the data is being collected and transferred to Google Sheets. Demonstrated the graph creation and live updates as more data is stored. Discussed the issue with Serial connection between Colab and the ESP32 chip.