sdmay23-22 Ultrasonic Radar

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Introduction

- The overview of this project is to create an object detection device using ultrasonic sound waves.
- This device will consist of a phase array of ultrasonic transmitters to allow for scanning at different angles.
- By using phase shifted signals the focus point of the beams can be angled without the use of mechanical movement.
- The device will be able to detect distances and angles of multiple objects.
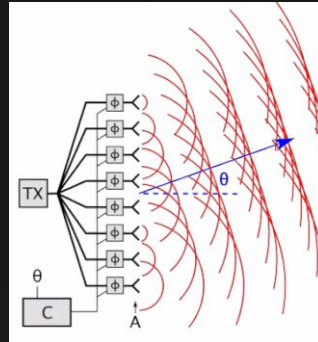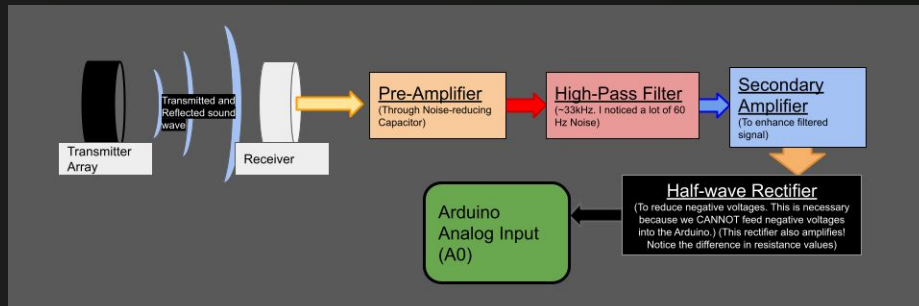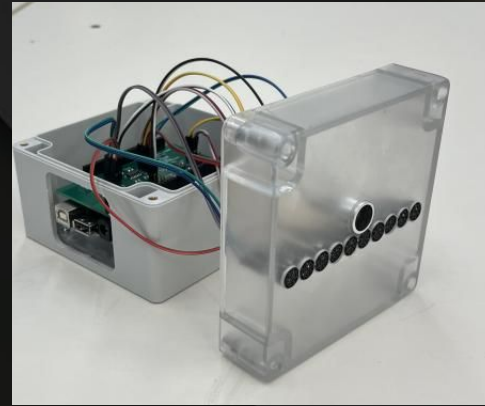
Background - Phase Array

By delaying the output waves at various time intervals, the pulses can be focused at different angles allowing for scanning without mechanical movement.
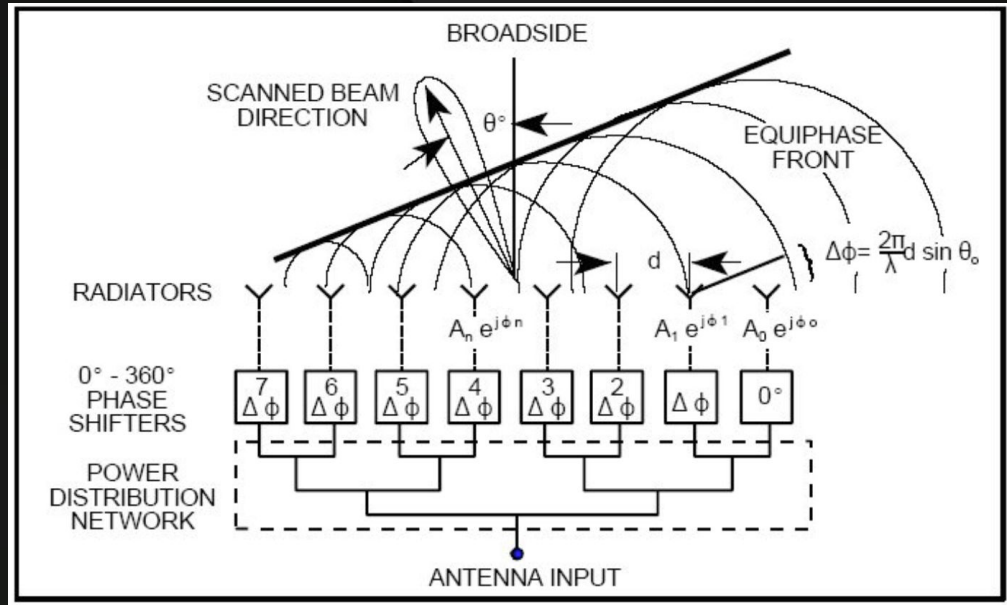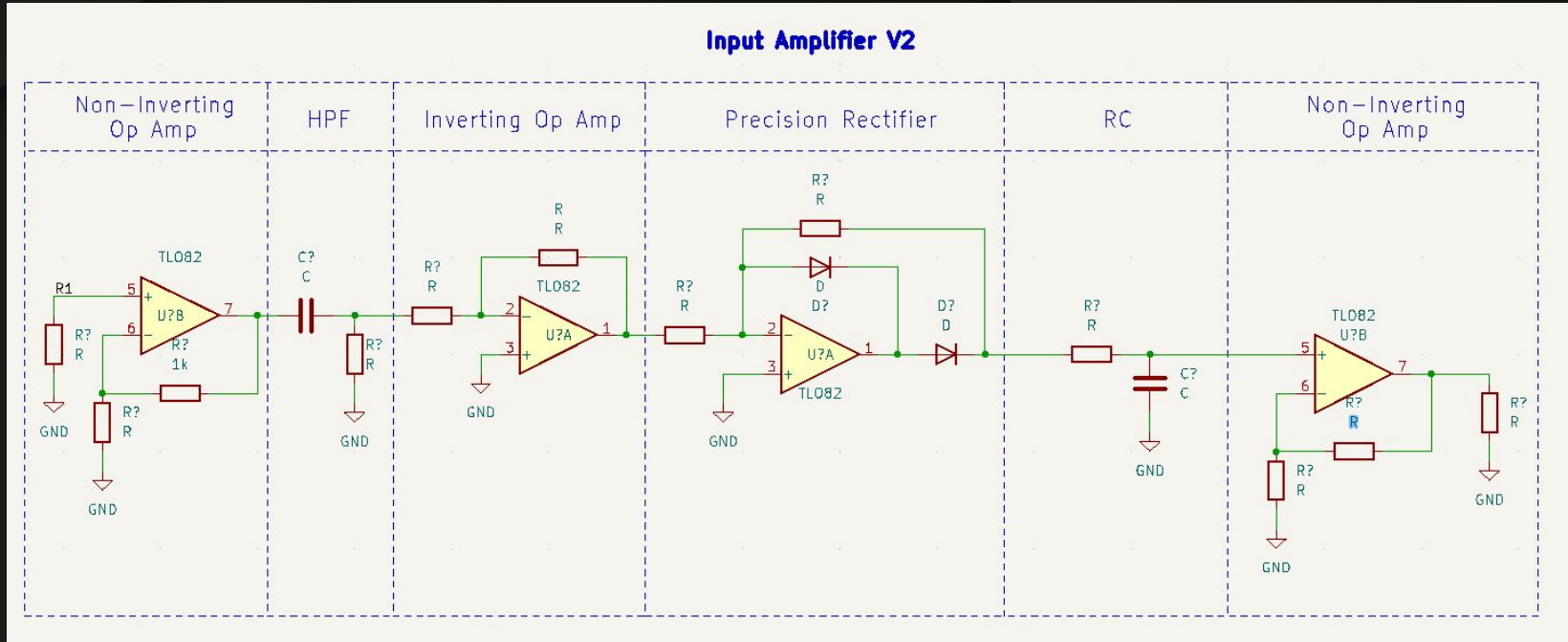
Implementations

1. Array of transmitters and receivers
2. Amplification circuit
3. Arduino-based code
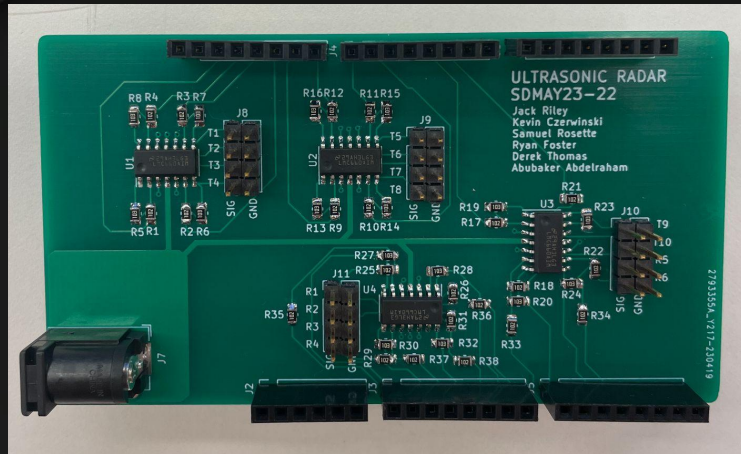4. Receiving circuit
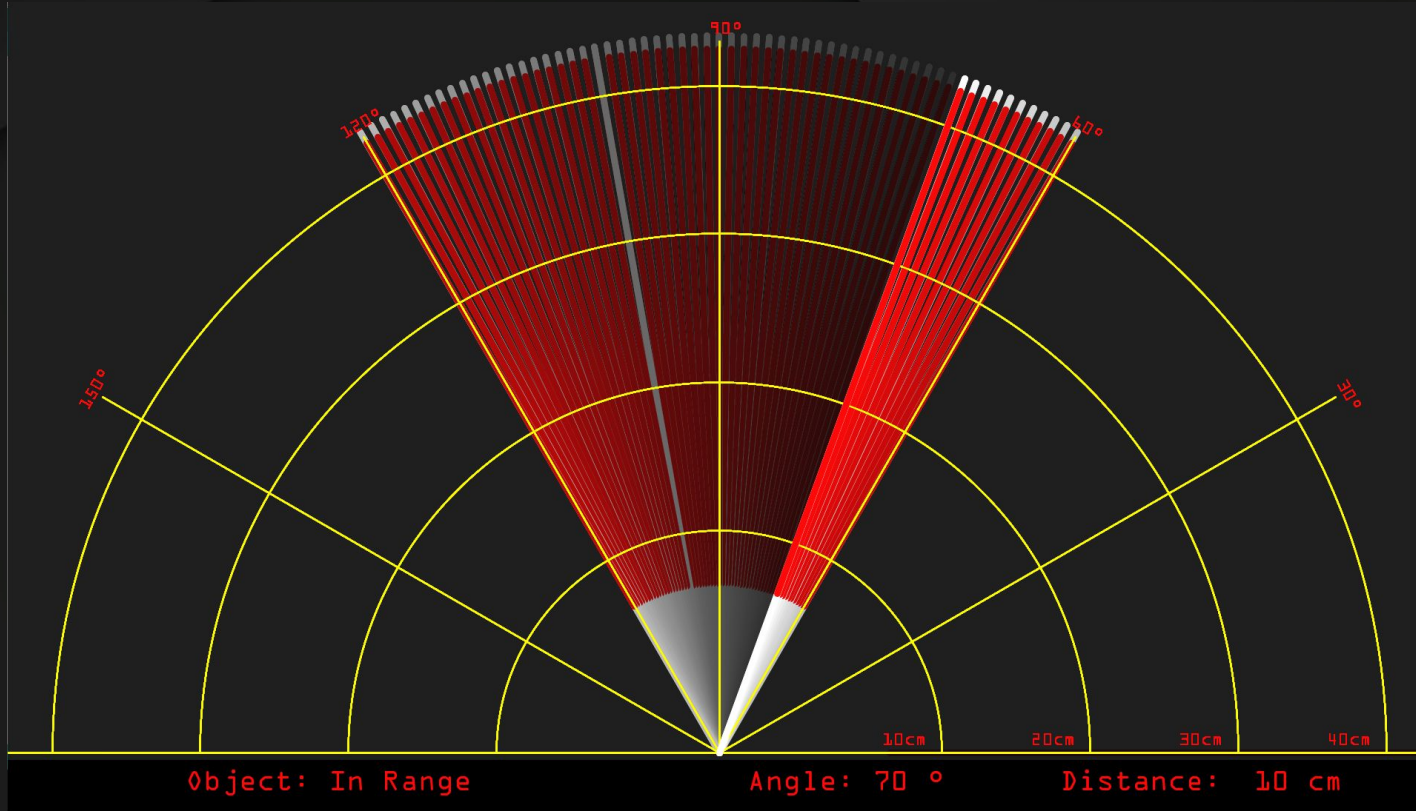5. User Interface (UI)
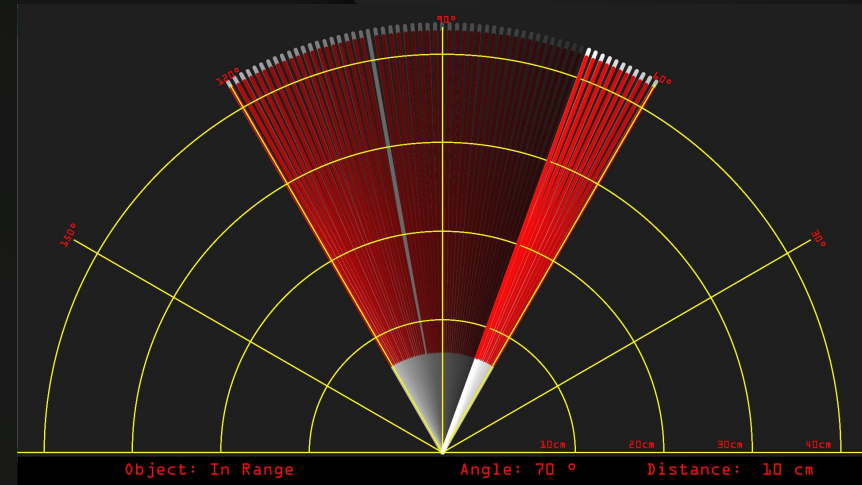
Work Accomplishments - Circuit

Final circuit Schematic:

Work Accomplishments - PCB/Case
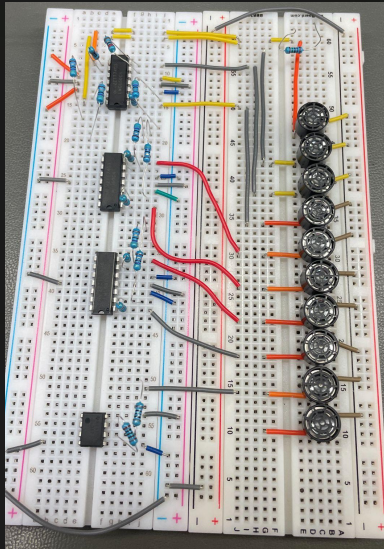
Work Accomplishments - Display Code

Challenges and Solutions - Circuit

Transmission Amplifiers were not working as intended so we decided to hook them up directly to the Arduino instead.

Receiving circuit was initially not working so it needed to be reworked entirely. Much of this problem was corrected by introducing a -5 V converter to power negative rails of the op amps
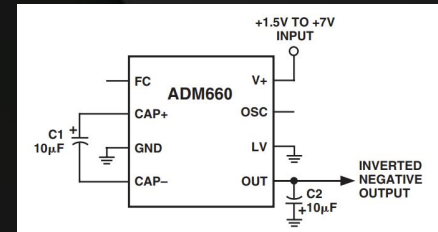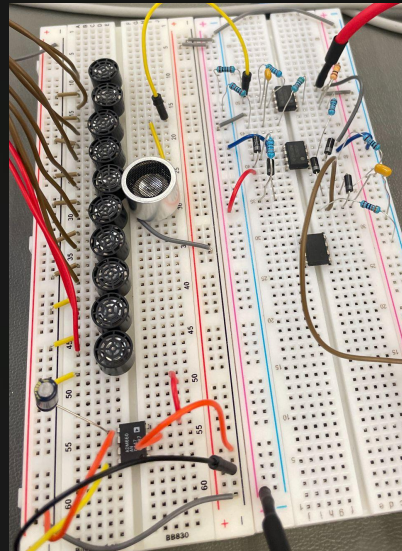
Challenges and Solutions - Case

- Originally Planned to 3D print the case.
  - The print failed twice
- Decided to mill out existing case
  - Took it to Boyd labs to help make the case

Challenges and Solutions - Phase Shift Code

Difficulty in determining proper method of producing phased-array:

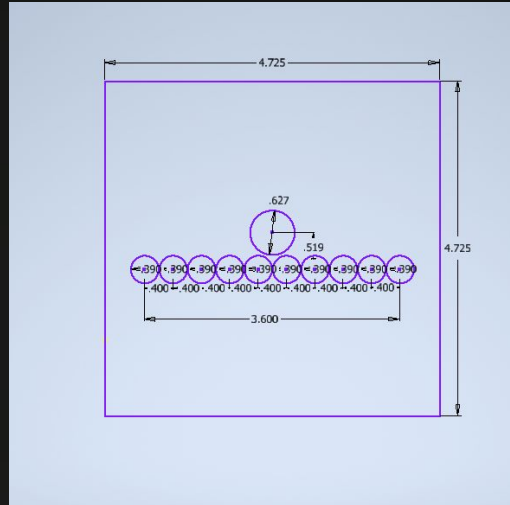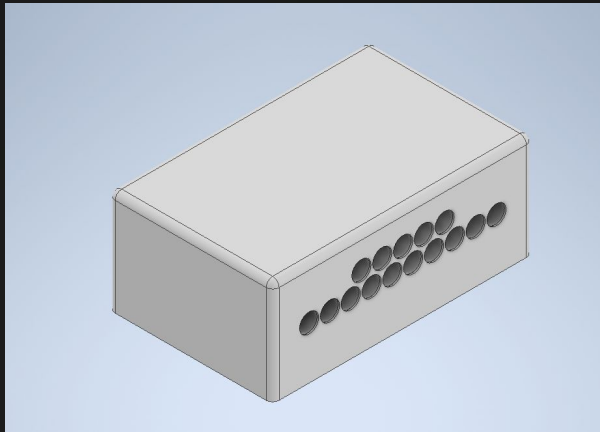Due to the fact that we're using the Arduino to control each transmitting element, difficulty does not arise in the circuitry, but within the code.

Why?

Our code must send pulses that **oscillate** with a period of 25 ms, while simultaneously controlling the phase difference at which these oscillations occur. Since code cannot run multiple functions at once, time calculations can get messy.

Potential Solutions:

- Different methods in controlling transmitted pulses
- Coroutines
- If/else statements ← More on this shortly

Challenges and Solutions - Display Code

- Communication with the Arduino

- Appealing visual
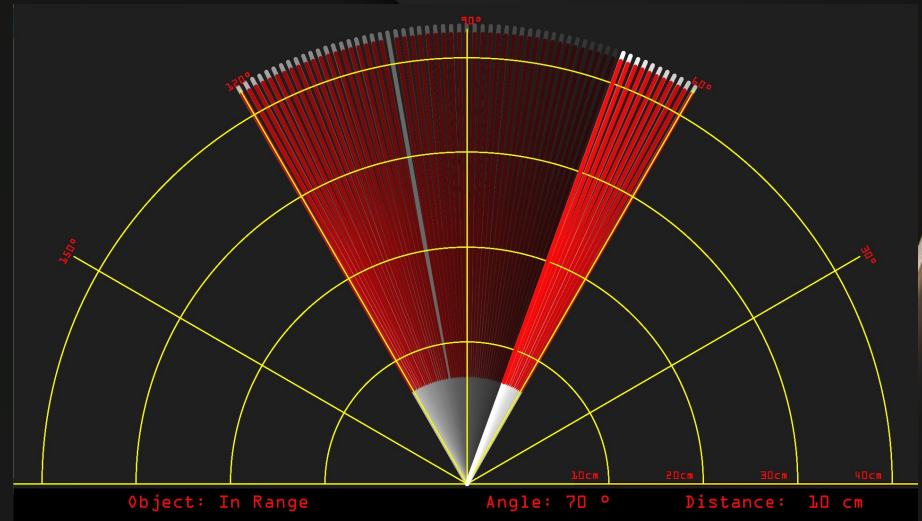
Future Work - Circuit

- Create working transmission circuit for sending out pulses
    - Increase maximum range and improve accuracy

- Improve receiving circuit to be more accurate
    - More precise measurements

- Increase power by using 12V or higher with a power supply
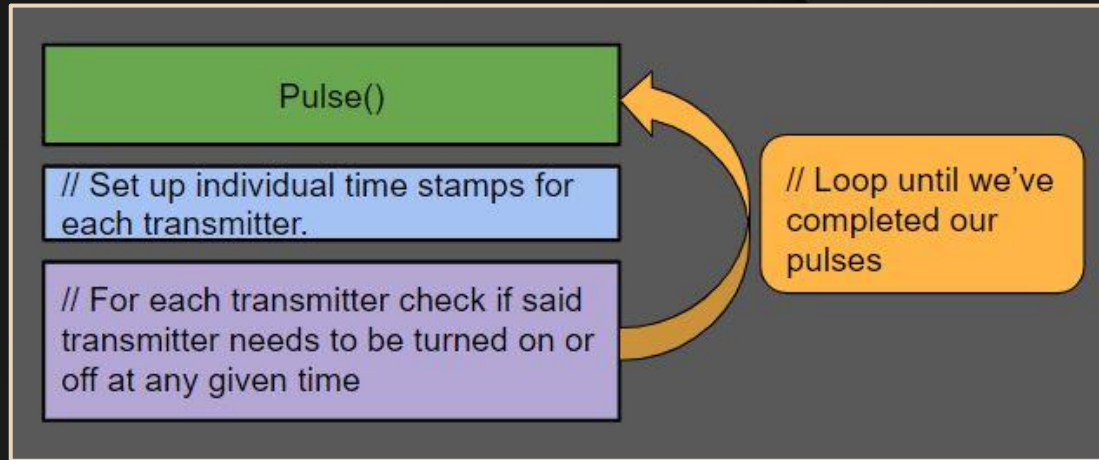   - Sends stronger pulses

- Update PCB

Future Work - Phase Shift Code

Time-Dependent If/Else checks

Pulse()

// Set up individual time stamps for each transmitter.

// For each transmitter check if said transmitter needs to be turned on or off at any given time
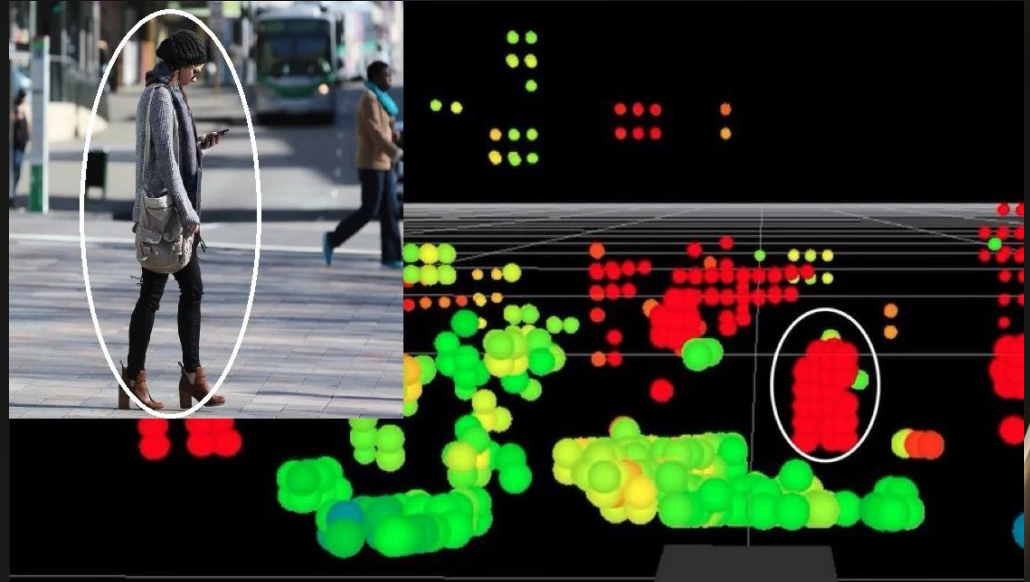
// Loop until we've completed our pulses

While this is not the only solution to our issue, it's our most promising method given our method of controlling these pulses.

Future Work - Display Code

- Scaling configurations

- Export data

- Descriptive imaging

Key Contributions

Kevin: Performed research and tested different hardware implementations. Engaged in troubleshooting and development of both receiving and transmitting circuitry. Assisted with PCB design and contributed to deliverables and reports.

Ryan: Research, testing, and development of code and hardware. Testing setup

Jack: Designed and soldered PCB, designed Case, helped with testing, helped develop final circuit, reshurched parts, and documentation.

Derek: Completed bi-weekly reports and researched transmitters. Able to get the radar UI functioning. Helped complete finishing documentation and code.

Samuel: Assisted with the testing of the amplification circuit, researched circuit components, worked on final report, and presentation.

Abubaker: Helped complete documentation, worked on the final poster, and presentation.

Conclusion

- Created an array of transmitters to detect a stationary/moving object.
- It provides accurate distance measurements, and support smart city initiatives making it a valuable tool for many applications.
- The Ultrasonic Radar can provide enhanced safety, convenience, and efficiency.
- Used concepts from Electric Circuits, signals & systems 1, integrated electronics, and Calculus.
- Thank you Professor Song and the Engineering Department.