Ultrasonic Radar

Group 22

Kevin(Hardware and software)

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Jack(Hardware)

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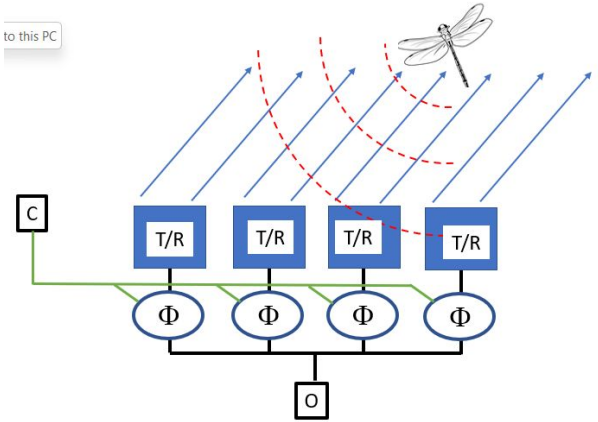
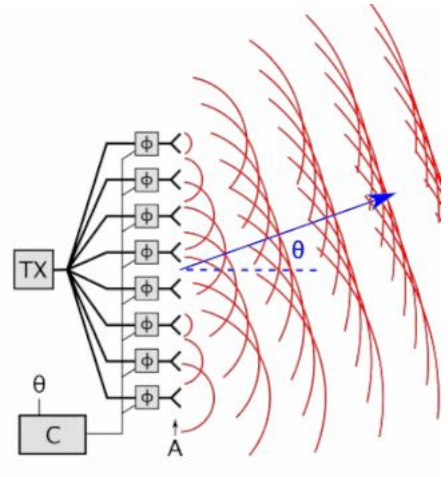
Advisor & Client

Dr. Song

Project Vision

- The goal is to build an ultrasonic radar to detect small objects
- Uses multiple sound transmitters and receivers
- Can calculate the distance between the object and the transmitter

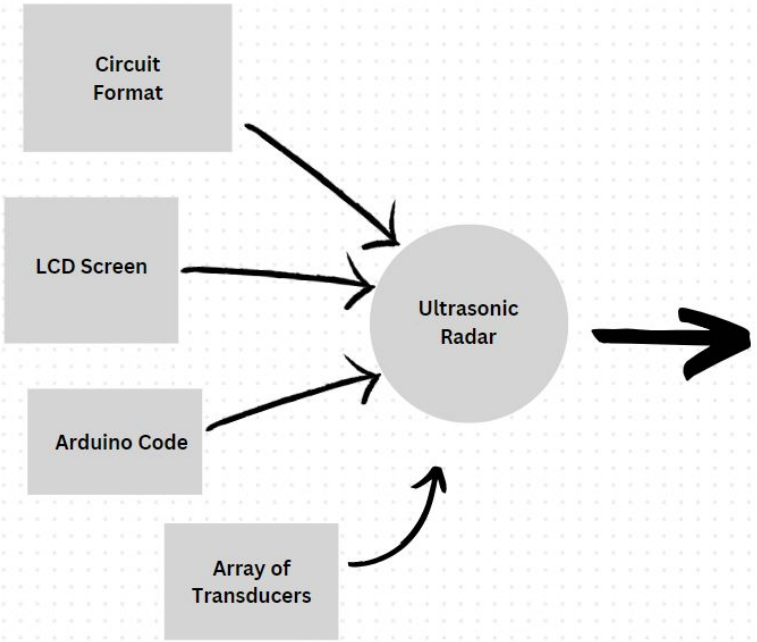




Intended Users and Uses

- Researchers/Scientists in environmental aspects
- Students studying ultrasonic waves
- Manufacturers that require ultrasonic detection

Conceptual/Visual Sketch



Intended Users

Scientists/Researchers studying the behavior of insects.
Students studying ultrasonic waves.
Manufacturers that require ultrasonic detection.

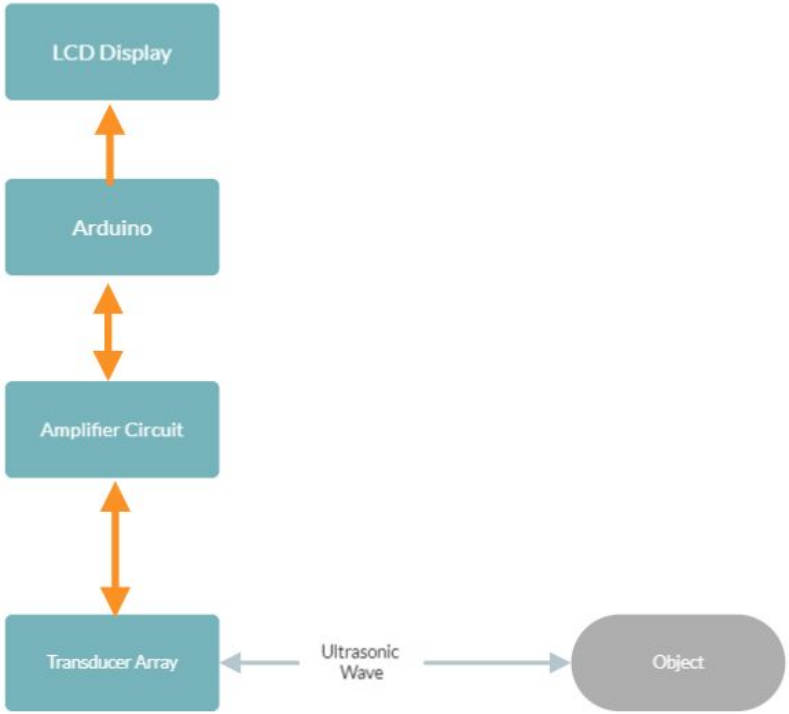
Requirements and Constraints

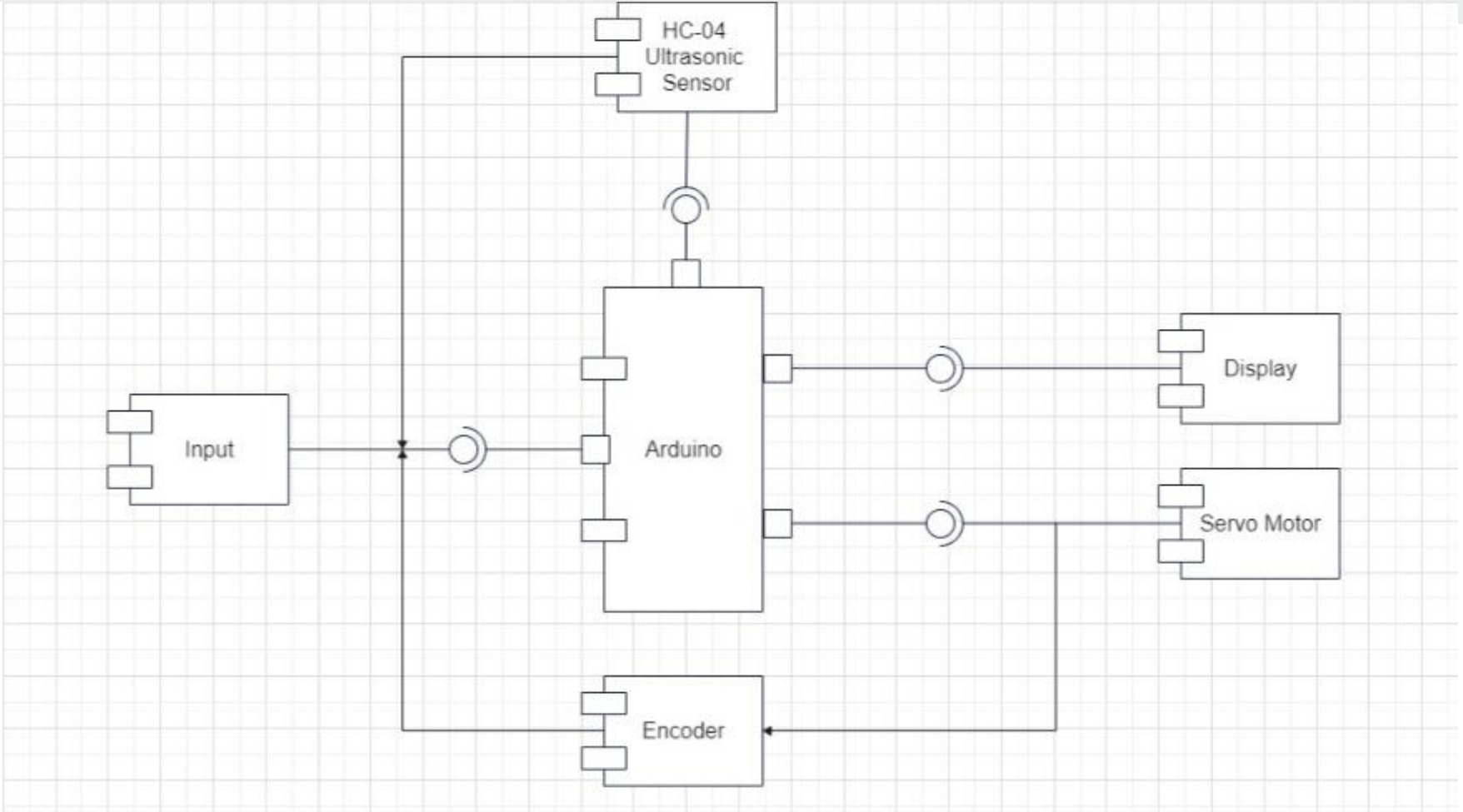
1) **Functional Requirements:**
   - Designing circuit to change phases to each transducer to control the scanning directions.
   - The mechanical wave is reflected back from any object and detected by the transducer
   - The time delay in the pulse-echo can be used to calculate the distance of the objects.
2) **Resource Requirements:**
   - Should be fairly affordable.
   - Parts from online or ETG that are available.
3) **Physical Requirements:**
   - Has to mechanically rotate.
   - Should be very durable because it will be used outdoors to detect insects.

Requirements and Constraints

1) **User Requirements:**
   - Can see how far the object is and how wide the object is.
   - Other objects shouldn't affect the data. One object shouldn't be seen as another object.
2) **UI Requirements:**
   - Be able to get 3D like images out of scanning in all directions.
   - Make a radar-like output and show where the object is on the map.
   - Return information about the object(distance, width, and general shape).

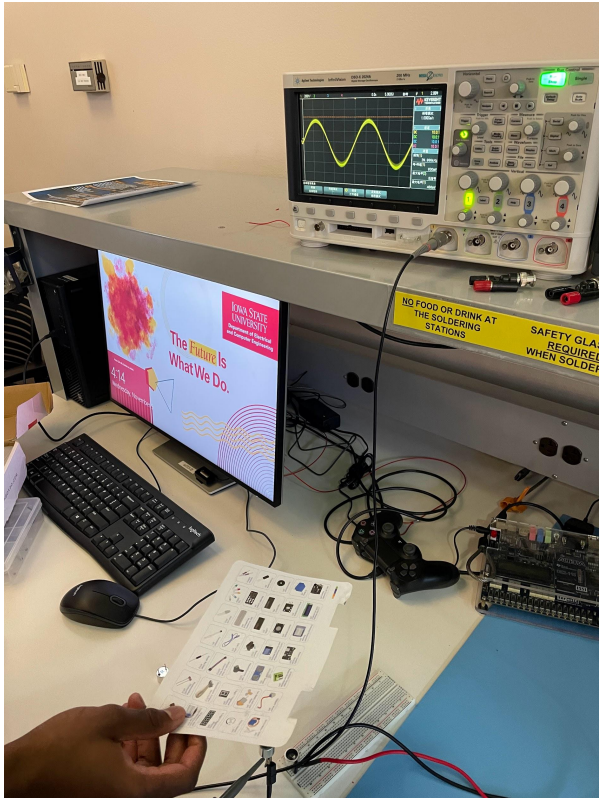
Conceptual Design Diagram




HC-04
Ultrasonic
Sensor
Input
Arduino
Display
Servo Motor
Encoder

Prototype Implementation

- Accuracy, precision, range, and additional capabilities
- Transmitter and receiver testing
- Interface testing - software and hardware components
- Making sure the outputs we desire are reliable



Time for a Demo!

Design Complexity

What made our design hard?

- Phase Array
- Figuring out how to output the data in a user-friendly way.
- Implementing the equations that we learned into our arduino code.

Design Iteration

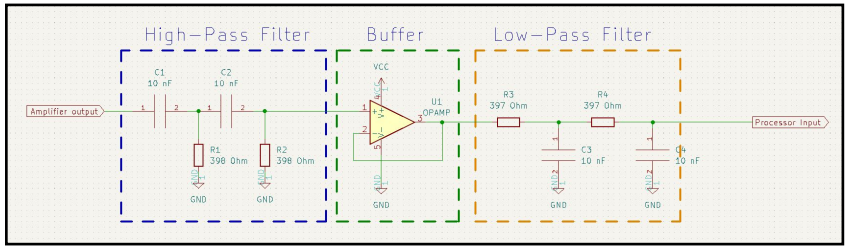
- The arduino code.

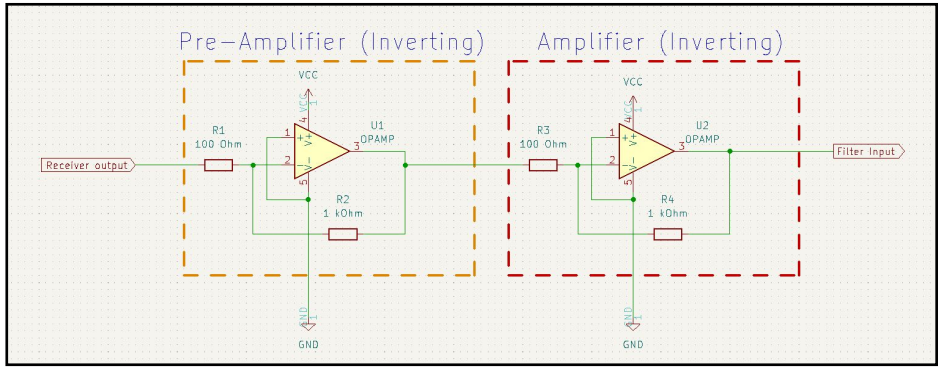
Decision-Making and Trade-Off Table

		Single Transmitter		Row of Transmitters		Matrix of Transmitters		Circular Pattern		Star Pattern		Ellipse Pattern	
Criteria	Weight	Score	Total	Score	Total	Score	Total	Score	Total	Score	Total	Score	Total
Cost	0.5	5	2.5	2	1	4	2	3	1.5	4	2	5	2.5
Complexity	0.6	1	0.6	3	1.8	4	2.4	4	2.4	5	3	4	2.4
Ability to Scan in Different Directions	0.8	1	0.6	4	3.2	5	4	4	3.2	3	2.4	3	2.4
Ease of Production	0.3	5	1.5	4	1.2	3	0.9	3	0.9	2	0.6	2	0.6
Accuracy	0.7	1	0.7	3	2.1	5	3.5	4	2.8	3	2.1	3	2.1
Total			5.9		9.3		12.8		10.8		10.1		10.1

Project Plan

- Our project does not come with too many risks
- We plan on redesigning the circuits and finding better transmitters and receivers to use for the final prototype

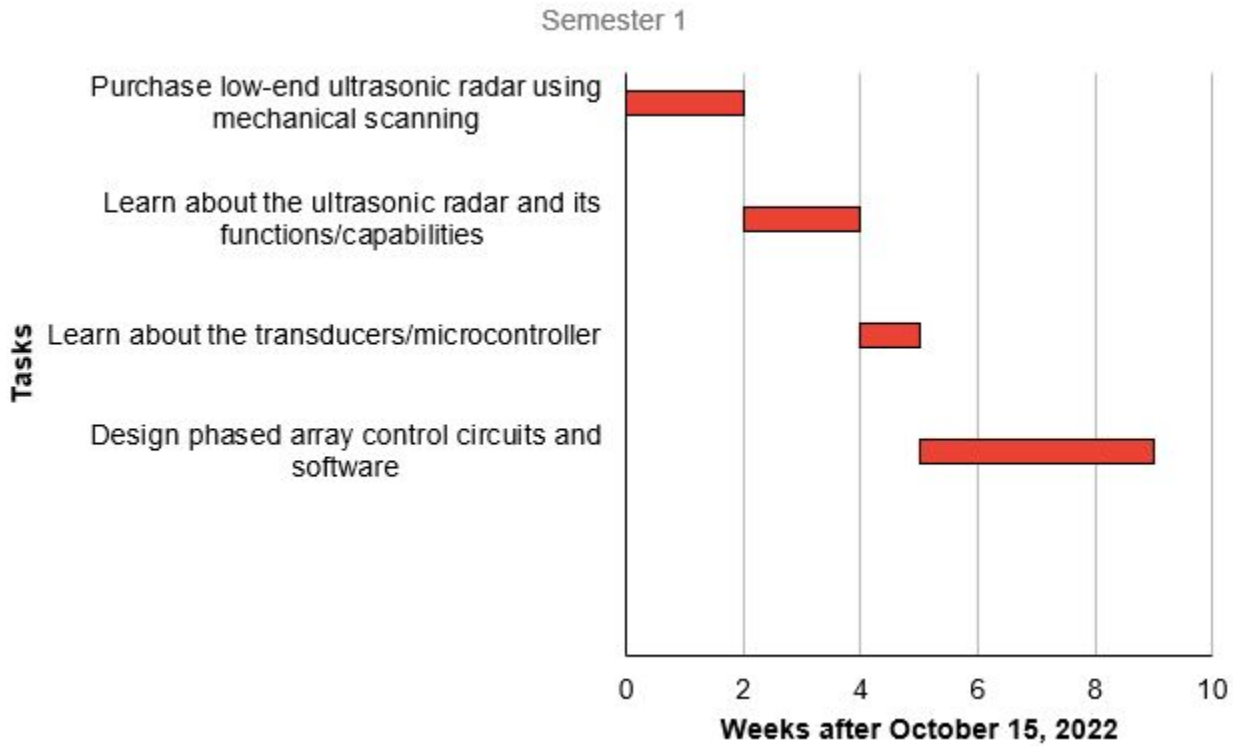




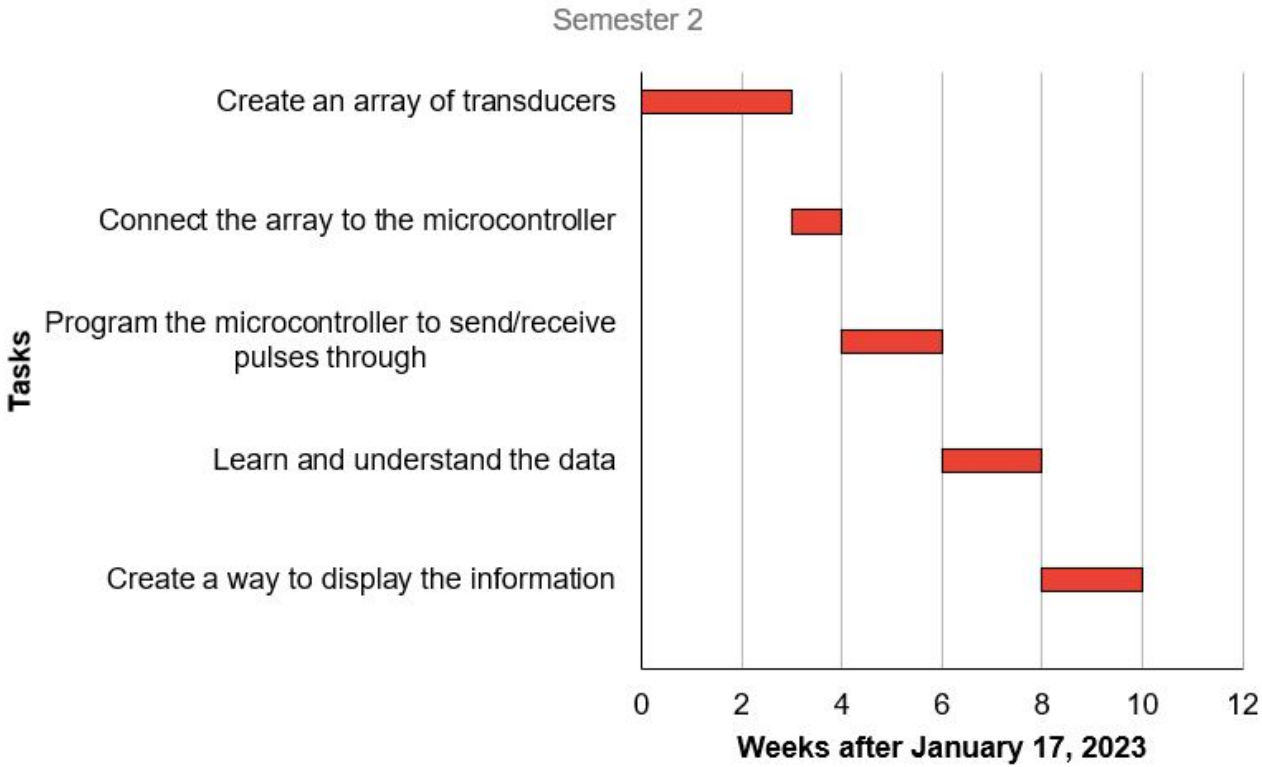
Main Tasks

1) Semester 1: Identify and purchase low-end ultrasonic radar using mechanic scanning.
2) Semester 1: Design phased array control circuits and software.
3) Semester 2: Build the ultrasonic radar using phased array, both software and hardware.
4) Semester 2: Have a demo and analyze the return signals.

Project Timeline(Semester 1)



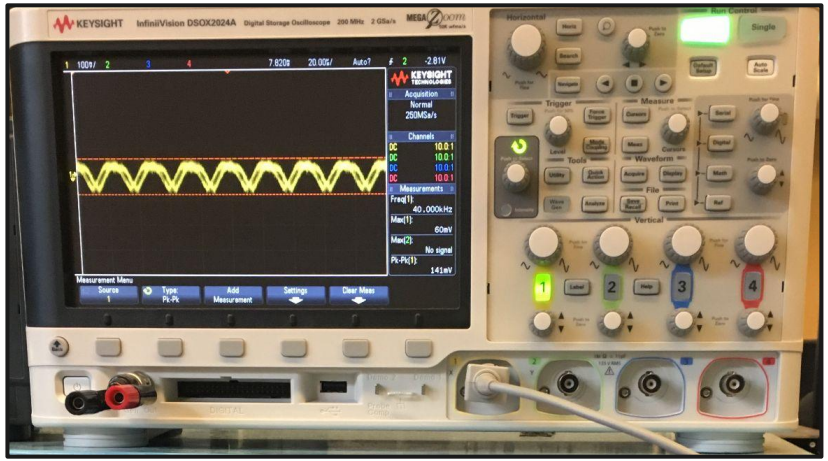
Project Timeline(Semester 2)

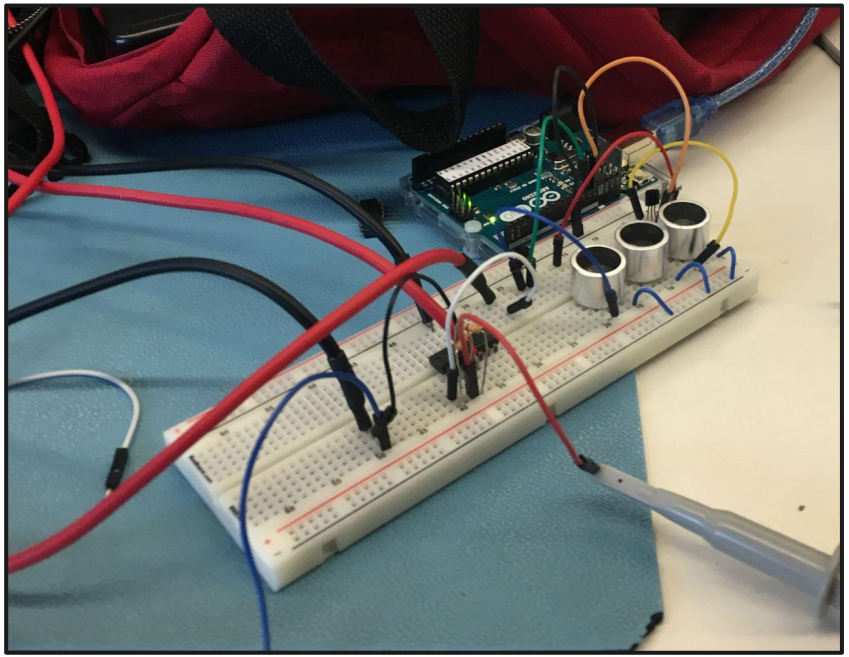


Test Plan

- Testing for our project is done by using the device with different objects placed at different distances
- We have already tested our current components and plan on testing the next line of ultrasonic emitters once we order higher quality ones

Component Testing





Conclusions

- Currently, we have completed all of the tasks and milestones for semester 1. We are doing research on some parts that will be needed next semester.
- Our plan for next semester is to build an ultrasonic radar using phased array which includes the software and hardware aspect. Lastly, we should be able to demo and analyze the return signals.

Team Contribution

Kevin: Hardware implementation and testing as well as documentation

Ryan: Hardware implementation and testing as well as documentation

Samuel: Assisted with the completion of design documents, presentation, testing, and planning.

Jack: Helped research transducers, complete presentation and documentation.

Derek: Put together the team website and also helped out with design documents and ideas.

Abubaker: Designs the component diagram and helped with ideas