EE/CprE/SE 491 WEEKLY REPORT 01

9/9/2024 – 9/16/2024

number: 36

Project title: **Ultrasonic Object Detector**

Client &/Advisor: Professor Jiming Song

Team Members/Role:
Nathaniel Clarke - Project Software Designer
Brock Dukhuis - Circuit Analysist
Nicholas Jacobs - Electronics
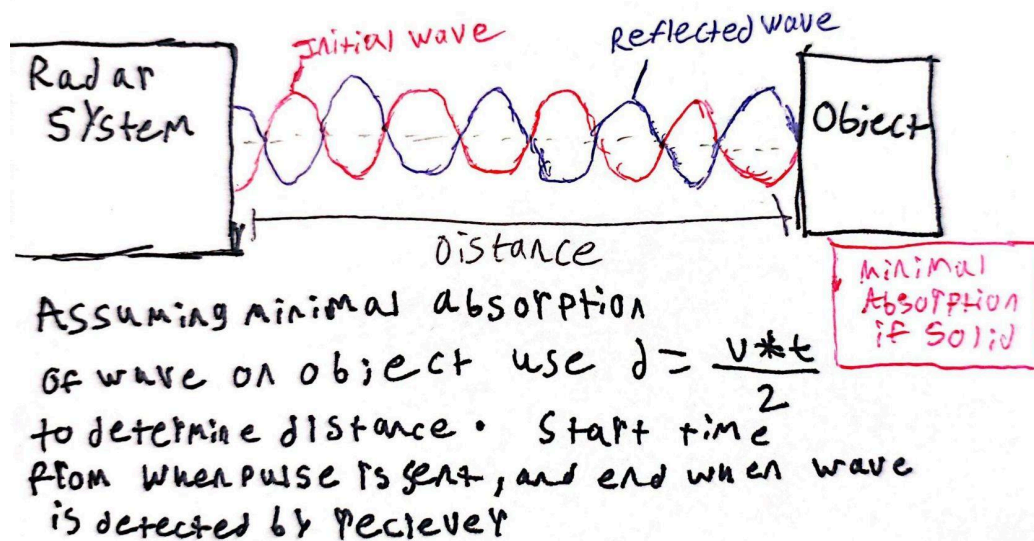**Jonathon Madden - UI Designer & Software Tester**

Weekly Summary

This week's work began arranging meeting plans with the project's client. After this the week primarily involved getting a foundation of understanding how the system will work. The majority of the group does not have the background for the topic, so much of this week's time was spent reading documentation, and researching how the system will work. In this week's meeting we were shown a presentation on the basics of a radar system with some of the important variables to consider. It was also mentioned that we are expected to improve on the past years design, so we will have to view the past project and treat as a baseline. It appears that the main decisions to make is what transducers and receiver to use, their placement, and their quantities.

Past week accomplishments

- Investigated past project's code base (sdmay24-24) - **Nathaniel Clarke**
  - Noticed presence of a .ino file and .html. It appears that the .ino deals with collecting information from the system, and the .html displays the results.
    - Will need to decide who will be working on which of these components
    - Began investigation into .ino using the source: https://docs.fileformat.com/programming/ino/

- Appears to be similar to C/C++, but is used for arduinos, indicating that the ultrasonic radar system will likely rely on an arduino board

- Investigated past project's Final Design Document (sdmay24-24) - **Nathaniel Clarke**
  - Viewing this project's timeline it appears that the software development for the project had not begun until the second semester (492). It will be important to figure out how to begin development with artificial data or example data to improve efficiency.
  - It appears that parts were not chosen until the end of the first semester (491). This potentially one area for improvement, an early selection may allow for more time to perfect the system.
  - It appears that using ten transducers were placed linearly with an object detection accuracy of 70%, which leaves significant room for improvement.
  - The need for stronger filtering was mentioned as a potential future need.

- Reviewed Professor Song's Power Point presentation - **Nathaniel Clarke**
  - Learned new terms necessary to understand the system
    - Impedance: Resistance to a wave's motion through the medium it is traveling. Calculated with impedance (z) = density of medium (p) * velocity of wave (v)
      - Our medium is air which has a density of approximately 1.2 kg/m^3
      - The velocity of a sound wave in air is approximately 343.7 m/s
    - Attenuation: Reduction of energy of a wave due to the medium it is traveling through. (can lead to a reduction of amplitude)
    - Transducers: Convert electronic signals to acoustic.
    - SNR (signal to noise ratio) 10 dB is needed for successful processing.
    - Phase Shift: the change in phase (position in a wave cycle) of a wave.
      - For radars this can be used to determine the distance traveled by a reflected wave, thus telling the distance of an object.

Radar Distance Determination

Radar System — Initial wave — Reflected wave — Object

Distance

Minimal Absorption if Solid

Assuming minimal absorption of wave on object use $d = \dfrac{v*t}{2}$ to determine distance. Start time from when pulse is sent, and end when wave is detected by reciever

- Looked into using a server to make the radar connect wirelessly to the display -**Brock Dykhuis**
  - Connect a raspberry pi to the scanner, this would upload the data to the server, the display will ssh into the server, this would allow for wireless communication between the display and the radar.

Research on Navy Applications of Ultrasonic Technology:

- Conducted detailed research on the use of ultrasonic radar in naval systems, focusing on submarine detection and underwater navigation.
- Reviewed Navy technical papers and case studies to understand the military standards for radar systems and their applications in both surface and underwater scenarios.
- Analyzed the benefits and limitations of using ultrasonic technology

System Design Adjustments:

- Based on Navy research findings, identified potential improvements in our radar system design to enhance detection accuracy in varying environmental conditions
- Explored ways to integrate components and techniques into our design, such as signal processing algorithms used in sonar systems.

Individual contributions

NAME	Individual Contributions *(Quick list of contributions. This should be short.)*	Hours this week	HOURS cumulative
Nathaniel Clarke	Studied past project's contents, and reviewed project documentation and further researched for understanding.	6	6
Brock Dykhuis	Looked through past projects, thought that if we use a server, this can be an improvement from previous designs.	5	5
Jonathon Madden	Looked over past projects and materials given by the client. Researched similar products.	4	4
Nicholas Jacobs	Used naval research to view similar ultrasonic devices and the components used in them to apply that	6	6

Comments and extended discussion

Viewing the past rendition of the project, there were six members on the team. To improve on their system we will have to be very time efficient. The past team had four electrical engineers, where as our team only has one member with that background. This is somewhat concerning due to the heavy focus on hardware for this project; it may prove difficult to evenly distribute tasks since our team primarily has a software background.

Plans for the upcoming week

Nathaniel Clarke: Will work on continuing to research and gain understanding of the system. Will potentially begin modeling the HTML for displaying the results image for the radar system.

Jonathon Madden: Will research parts and keep looking over previous classes projects.

Nicholas Jacobs: Will be working on creating the schematic layout for the project and be responsible for a majority of the electronic components in this project

Summary of weekly advisor meeting

This week's meeting was primarily focused on introducing the specifics of the project. It also functioned to introduce key concepts that define how a radar system works. It was discussed that our product should improve upon a past design from another senior design group last year. It is expected that we begin work earlier than the past group, and quickly figure out what parts are necessary to begin designing the hardware of the system.