Detailed Design

Ultrasonic Object Detector
sdmay25-36

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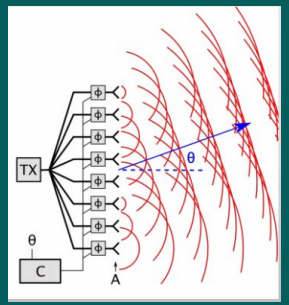
Project Overview

- Design an ultrasonic radar



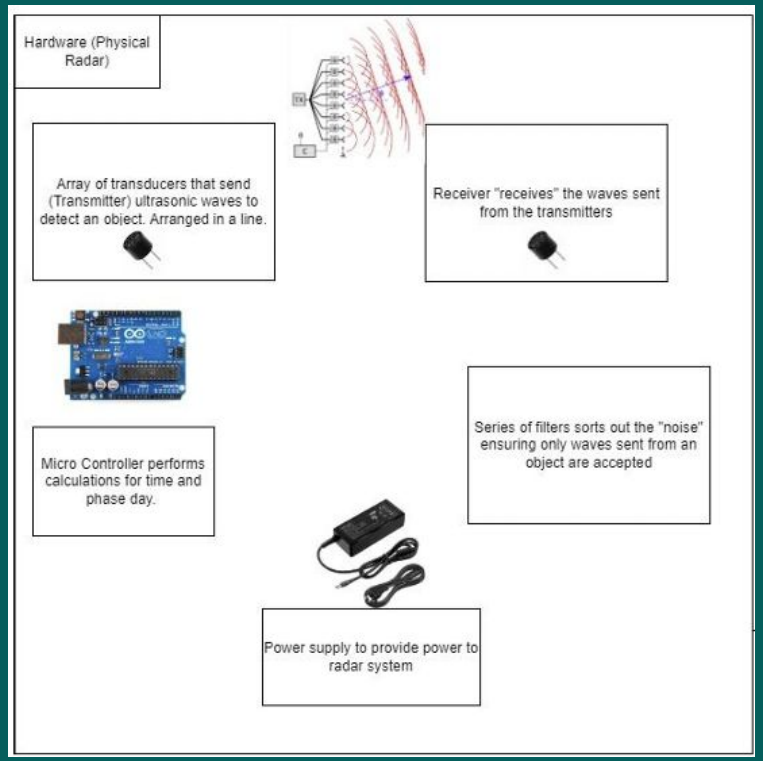
- Array of transducers
- Rely on reflected sound waves to determine object distance
- Use of time-delay (phase) to control scanning direction and location

Problem Statement

- Design an Ultrasonic Radar System which can detect small objects
- Accurately detect two side-by-side objects
- Effectively convey an image through the use of an intuitive display

Detailed Design Hardware

- The hardware describes the physical radar system
- The end goal of the hardware is to send angle determined by phase delay and the distance base on the time delay data to the Raspberry Pi
- The power supply powers the radar system.



The MCU

- The MCU sets the phase delay for the next pulse (this focuses the direction of the scan)
- The MCU determines the time delay based on the time a pulse is sent.
- The time delay is used to calculate the distance using the approximate speed of the pulse
- The phase delay gives a range of angles which, can further be calculated for a particular scanned object.

The Transducers And Filters

- The Transmitters send ultrasonic waves that are used for object detection. These are placed in a linear pattern to function as a phase array
- The Receiver detects the waves that reflect off a detected object.
- The filters remove the noise (remove the frequencies that are significantly out of range) to make the detection more accurate

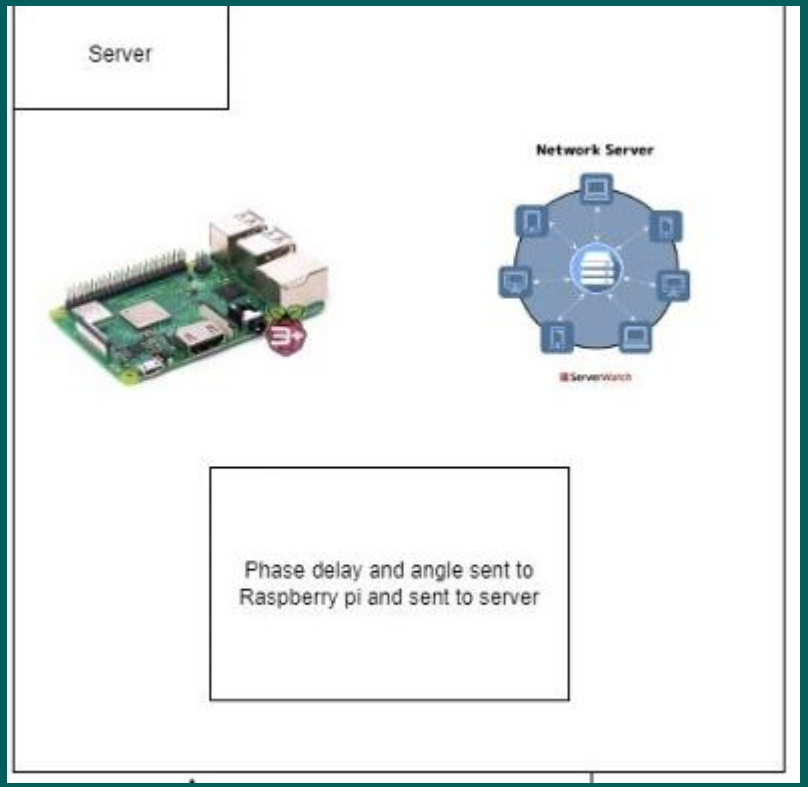
Transmitter

Receiver

Detailed Design

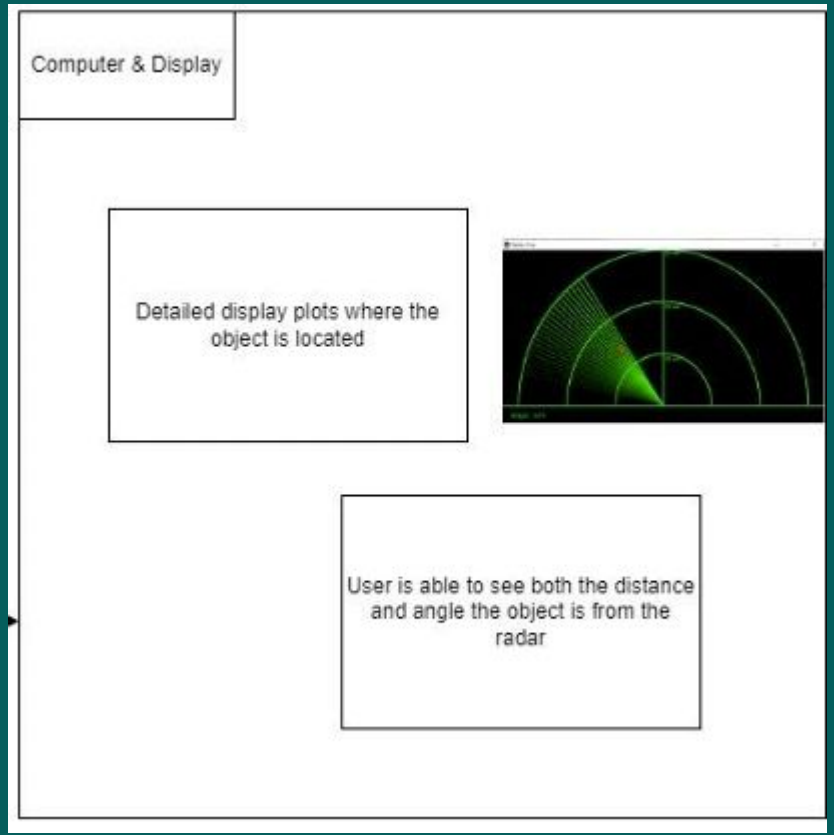
Server

- Raspberry Pi puts data on a web server to transfer to the computer to display.
- The server transmits data over a wireless connection.



Detailed Design Display

- Data is received from the raspberry pi and processed to create a user friendly display.
- The display will show an object's direction and distance.
- An objects is depicted as a Collection of points.



Functionality

- Our radar can be used for simple object detection
    - The transducer we picked cannot be used for military or security purposes, and it is not rated for outdoor use.
- The user will get the location of the object on a on the radar display
    - They can decide what they what further analysis is needed, depending on their use case.
- The radar will be able to detect two or more separate objects in close proximity
- The radar will be accurate up to a range of 1 meter.

Technology Considerations

- Raspberry Pi
  - Pros - cheap and easy to set up
  - Cons - can be slow
- MA40S4R/S
  - Pros - cheap and small, has a high range of detection and signal to noise ratio
  - Cons - high db value (120) can be damaging to the hearing
- ESP32 microcontroller
  - Pros - cheap and efficient for data processing
  - Cons - could be difficult to integrate with the raspberry pi

Areas of Concern

- One area of concern is that the transducers will be able to accurately send out a signal for a distance of 1 meter which can be further processed.
  - It will be challenging to create a display that is accurately depicts a smaller distances within the overall range of one meter (down to the millimeter).
  - The microcontroller, raspberry pi, and display will communicate efficiently and transfer data correctly.
  - With the data being processed and manipulated 3 times, we will have to make sure that everything works together smoothly.
- Create a clear display
  - Display is not muddy (if it is depicted with a heat map the streaks should not be exceedingly large)

Questions?