Project Report
TERRAIN MAPPING RADAR

Team Details

Name	Roll number	Contact No.	Email ID
Nikhil Meena	22B2263	8107771400	nik81077@gmail.com
Yash Gupta	22b2151	8078692865	yashg1810@gmail.com
Khushajh Verma	22B2128	9950525333	khushajh2004@gmail.com
Divyansh Ranjan	22b3960	8318806303	divyanshranjan2099@gmail.com

Current Project Stage?

We are currently in the software phase/ hardware & software integration phase.

Description *(in 80-100 words)*

Our project is a ground-based radar system, which would be able to detect and range objects around it; effectively displaying a low-resolution map of its surroundings on a digital screen. Our system is designed to work on a frequency of 433 Mhz and would be able to detect objects larger than 0.7 meters in length. The yagi-uda antennas used for transmission and reception give our radar a range of up to 70 meters; while the radio waves are generated and encoded by ASK modules and a Raspberry Pi respectively.

Work Distribution

Though we mention specific tasks under specific team members, there was no single task that one particular member did on his own. All four of us more or less contributed equally to all aspects of the project.

Divyansh:

1. Figuring out the mechanism for a small-scale radar.
2. Yagi-uda antenna research and implementation.

Nikhil:

1. VNA testing of the yagi-uda antenna; figuring out input to the antenna.
2. Learning about Ras-pi; Display mechanism.

Yash:

1. Realizing the transmitter and receiver circuits using Arduino-unos
2. Buying/acquiring the materials from shops/clubs.

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Khushajh:

1. Learning Python basics; Writing the final code for the Ras-pi-based circuit.
2. Circuit implementation using ras-pi; Research on duplexing.

Work Done Till Date

1) First, we conducted long and thorough research on the transceiver ICs, the circuitry, antenna. Then, we designed a CAD model for our antenna.

2) Secondly, we made a transmitter using an Arduino but we had to give up the idea because we did not have sufficient time to replicate 2 professional grade ICs. The time interval of the transmitting and receiving waves was calculated to be much smaller than the clock time of Arduino that's why we had to ditch the idea of using Arduino.

3)After that, we used ASK modules with Arduino to implement and test a transceiver system.

4)Next, we started the work of constructing a completely functional Yagi-Uda antenna using

steel tubes, wood, and coax. For that, we did all the required calculations for identifying the exact length of the reflector, the driven element, the directors, and the distance between them. We also had to spend some time deciding and acquiring the suitable material for all these components.

5)Next, we moved on to the testing of the antenna. We used the SSP lab to conduct a VNA test on our antenna.
The results were as follows:
In the S11 vs frequency plot, we got a dip(reflection coefficient is minimum at this point)at a frequency of 433MHz and the gain observed was 7. This implied the range of Tx transmission from the Antenna to be 150 m.

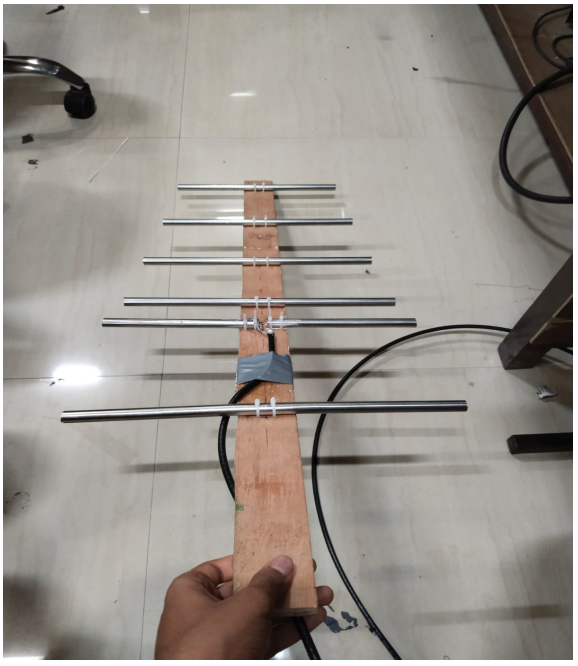
6)Till then, we had figured out that we would have to use Ras-Pi instead of Arduino so we started figuring out the Ras-Pi coding and circuitry.

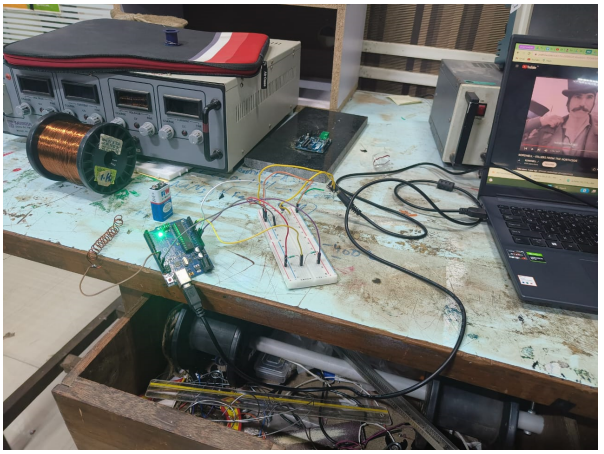
7)After that, we proceeded with our research on the output display that would be shown in the final presentation.

8)We are also looking into the rotational mechanics of our antenna and have started with CAD modeling.

Overall, approximately 70-75% work has been completed till now.

```
import machine
import time

TRANSMITTER_PIN = 2  # GPIO pin connected to the transmitter IC
RECEIVER_PIN = 3  # GPIO pin connected to the receiver IC

def setup():
    global transmitter_pin, receiver_pin
    transmitter_pin = machine.Pin(TRANSMITTER_PIN, machine.Pin.OUT)
    receiver_pin = machine.Pin(RECEIVER_PIN, machine.Pin.IN)

def transmit_pulse():
    transmitter_pin.on()
    time.sleep(0.1)  # Adjust the sleep duration as per your requirements
    transmitter_pin.off()

def receive_pulse():
    while receiver_pin.value() == 0:
        pass
    start_time = time.ticks_us()
    while receiver_pin.value() == 1:
        pass
    end_time = time.ticks_us()
    time_period = (end_time - start_time) / 1000000  # Convert to seconds
    return time_period

# Setup pins
setup()

# Example usage
time_period = receive_pulse()
print("Time period between transmission and reception:", time_period)
```





Online Yagi-uda calculator-
https://www.changpuak.ch/electronics/yagi_uda_antenna_DL6WU.php

Progress after Review Meet

Before Review Meet 1, almost all the work done was focused on research and CAD modeling. The actual hardware and implementation work began after the Review Meet 1.

We started by working on the transceiver system and implementing it. After that, a fully functional Yagi-Uda antenna was constructed using steel tubes, wood, and coax. Then, the antenna was tested in the SSP lab and it gave satisfactory results. After that, work has been started on Ras-Pi but we are having problems in acquiring Ras-Pi from the institute so the process has been delayed a bit. Research has been going on simultaneously on the final output display and the rotational mechanics of the Antenna.

Facing any difficulties?

As soon as we started with the research work of our project we realized that the resources available for making a complete radar system are quite limited. At first, we were using an Arduino Uno for the project but we realized that it was impossible to do this project with it due to its higher clock speed. Then we required a raspberry-pi but we are facing problems in obtaining it.

Since all of us had limited experience in coding we found it difficult to develop the code. We solved this problem using various online resources and then

tailoring the code as per our needs through testing.

Post this we started our research on duplexing which would have allowed us to use the same antenna for transmission and receiving, but we realized building a duplexer is tough. So we have finally decided to build another antenna. The problem that we now have to sort out is the integration of the two antennas and making them work together.

Current tools and hardware in use?

The hardware component of our project includes building a Yagi-uda antenna. In order to build it we used a wooden cuboidal block and then fastened aluminum rods of appropriate length on it using zip ties. Since the wooden block has a flat surface we get a more robust and sturdy antenna. Zip ties are easily replaceable in case we want to do some modifications.

Our initial testing took place using Arduino Uno, but now for our actual project, we are trying to obtain a Raspberry Pi.

We used an online calculator that prompts the user the length of the reflector, radiator, and director rods of the antenna for a given frequency. (https://www.changpuak.ch/electronics/yagi_uda_antenna_DL6WU.php)

For our final presentation, we'll be using an open platform named Processing to display the detected object.

References

EE602 Notes - Link
Relevant videos - Link
Final circuit with rasp pi - Link
Additionally, we went through many more resources on the internet regarding Arduino and its clock speed, duplexer and its working, etc. that we don't have the links for.

Final Presentation?

In our final presentation, the entire radar setup would remain stationary while it detects and ranges its surroundings and displays a low-resolution map of the same on an LCD screen. As per our operating frequency and design, our radar would have a range of up to 70 meters.

We would demonstrate the working of the radar in the gymkhana ground by mapping the boundaries near the new sac; and if time permits, we would also use a self-made terrain (consisting of random large objects) for a better showcase of the radar's functioning.

Bills & expenditures till now

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