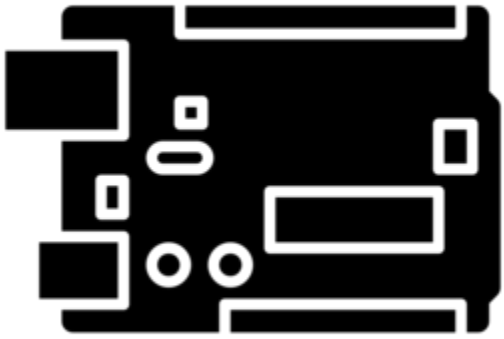
PROJECT REPORT: OBJECT DETECTION RADAR SYSTEM USING ARDUINO AND PROCESSING

25 Maret 2025

A SMALL PROJECT

Ibra Khalid Londang



-keep trying

1. Introduction

Radar systems are crucial in modern technology for detecting and tracking objects. Traditionally, radar systems are used in military and aviation applications to locate obstacles, aircraft, or enemies within a certain range. With the advancement of microcontrollers and open-source platforms, it is now possible to develop a simplified version of radar systems for educational and prototype purposes.

This project aims to simulate a basic radar system using Arduino and Processing. The system is built using an ultrasonic sensor (HC-SR04) for measuring distance, a servo motor for scanning, and the Processing IDE for visualizing the scanned data in a radar-like interface. The project also lays the groundwork for future implementation in security systems or military defense systems, making it an ideal introduction to IoT-based radar technologies.

2. Objectives

- To design and implement a simple radar system using Arduino UNO.
- To detect objects using the HC-SR04 ultrasonic sensor.
- To visualize the scanning data in real-time using Processing.
- To understand the fundamentals of radar scanning and object detection.
- To explore the potential of integrating basic radar systems into IoT and security applications.

3. Components and Tools

Components	Function
Arduino UNO microcontroller board	As the brain of the system. Arduino UNO controls all other components by reading data from the ultrasonic sensor and regulating the movement of the servo motor..
HC-SR04 Ultrasonic Distance Sensor	Measure the distance between the sensor and the object in front of it by sending ultrasonic waves and calculating the time it takes for the waves to bounce back.
SG90 Servo Motor	Moving the ultrasonic sensor in a horizontal direction to scan the area like a radar.
Breadboard	As a solderless breadboard, it allows you to connect components temporarily.
Jumper Wires	Connecting the pins between components, such as from Arduino to the sensor and servo.
Arduino Aplication	Programming platform for writing and uploading code to Arduino. (Arduino Downloader)
Processing Aplication	Displaying data from Arduino in the form of an interactive visual radar on the computer. (Processing Downloader)
Simulation platform	Conducting a virtual project simulation before assembling it physically.

4. System Design and Circuit Diagram

The radar system uses the HC-SR04 sensor mounted on a servo motor. The servo rotates from 0 to 180 degrees and back, allowing the sensor to scan the surroundings. The ultrasonic sensor sends distance measurements to the Arduino, which are then transmitted via serial communication to the Processing application. Processing interprets this data and displays it visually, creating a radar-like effect.

Wiring Configuration:

- VCC of HC-SR04 to 5V on Arduino
- GND of HC-SR04 to GND on Arduino
- TRIG to digital pin 10 on Arduino
- ECHO to digital pin 11 on Arduino
- Servo signal to digital pin 9 on Arduino
- Servo VCC to 5V, GND to GND

5. Arduino Program Overview

The Arduino code controls the servo motor to sweep back and forth between 0 and 180 degrees. At each step, it takes a distance measurement using the ultrasonic sensor. This data (angle and distance) is formatted and sent over the serial port. The data is structured in a way that the Processing application can read and parse it easily.

6. Processing Program Overview

The Processing code listens to the serial port for incoming data from the Arduino. It processes the angle and distance values to plot points on a circular interface that mimics a real radar screen. The interface includes animated sweeping motion, object detection indicators, and color effects to enhance the user experience. This visualization helps to understand object location and movement patterns in the scanned area.

7. Testing and Results

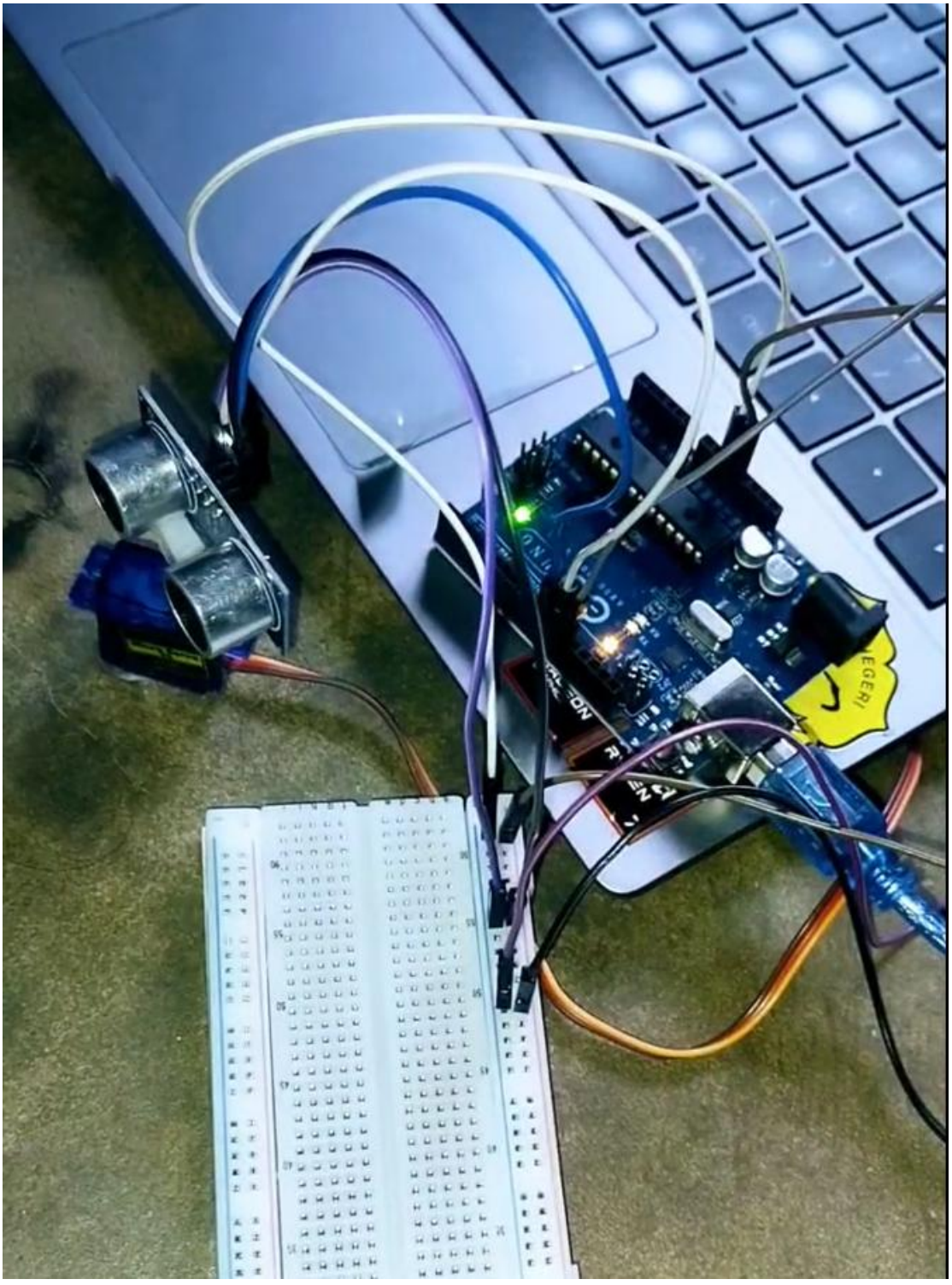
The radar system was successfully built and tested. During the test:

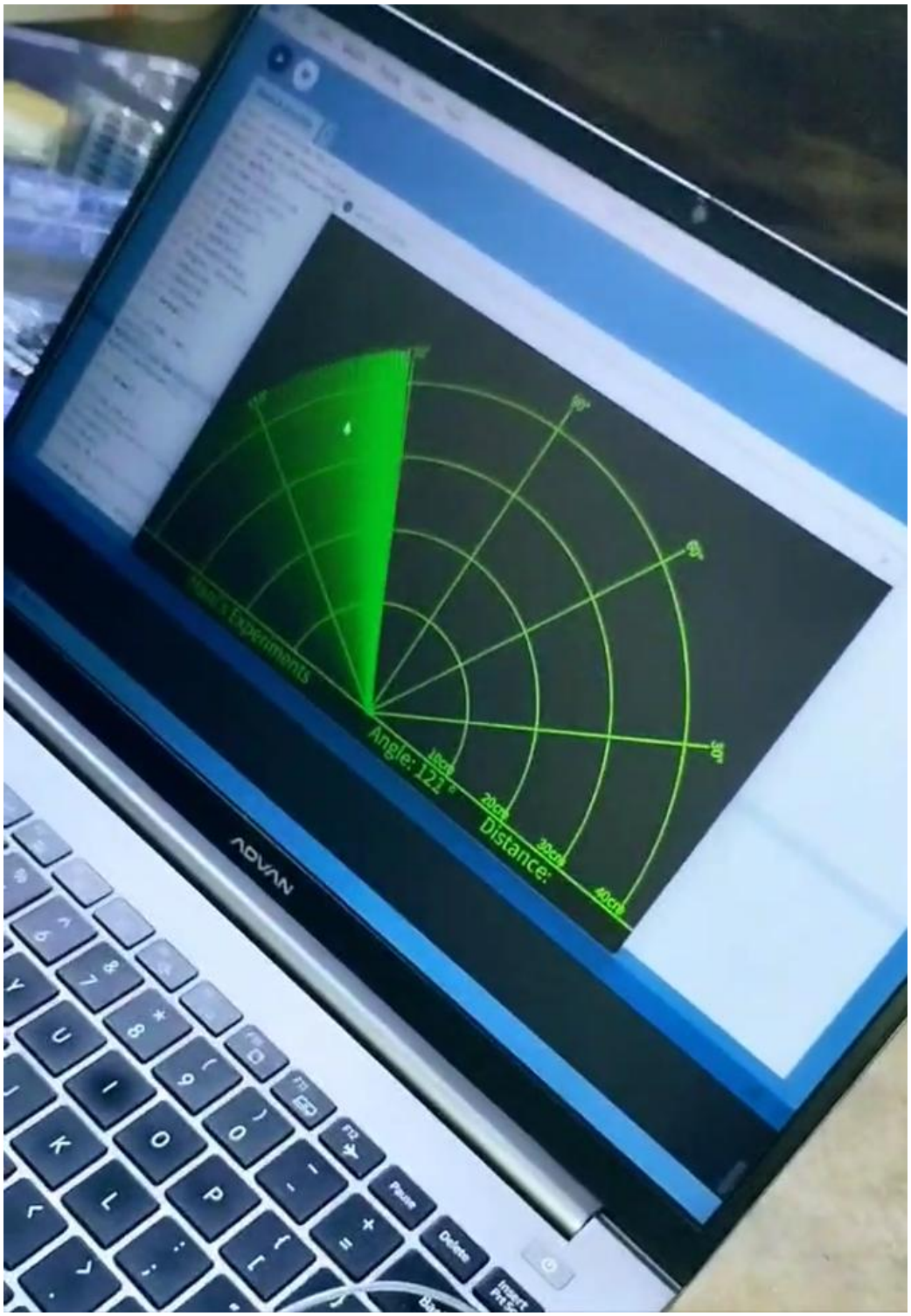
- The servo motor smoothly rotated and allowed scanning of a semi-circular area.
- The ultrasonic sensor accurately measured distances to nearby objects within its range (up to 4 meters).
- The Processing application correctly interpreted and visualized the radar data.
- Moving objects were detected in real-time, and their position was displayed on the radar screen.

8. Project Documentation

8.1. Hardware Setup

The following image shows the wiring and component arrangement used in this project. All components were connected on a breadboard and tested through simulation and physical deployment.

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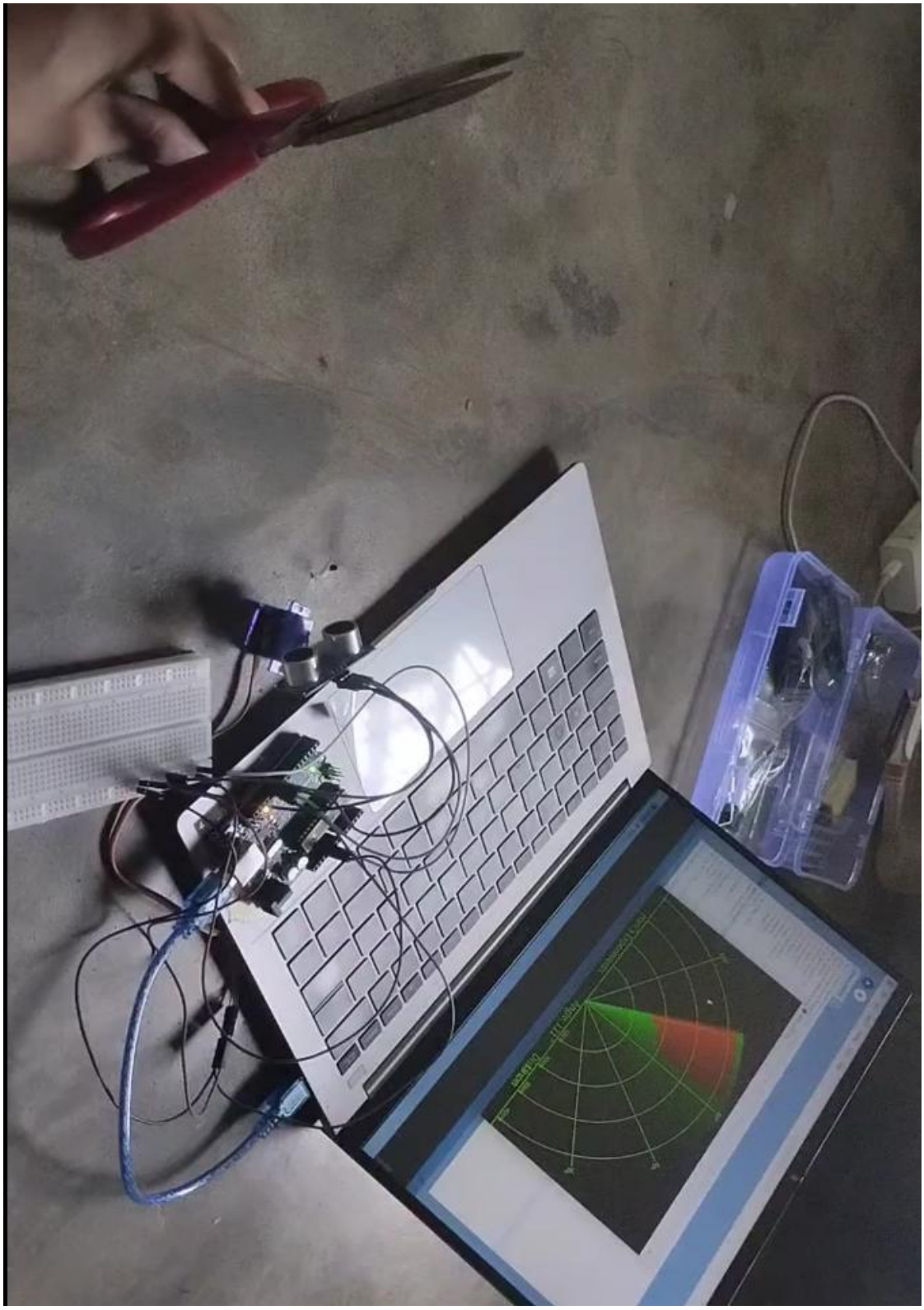
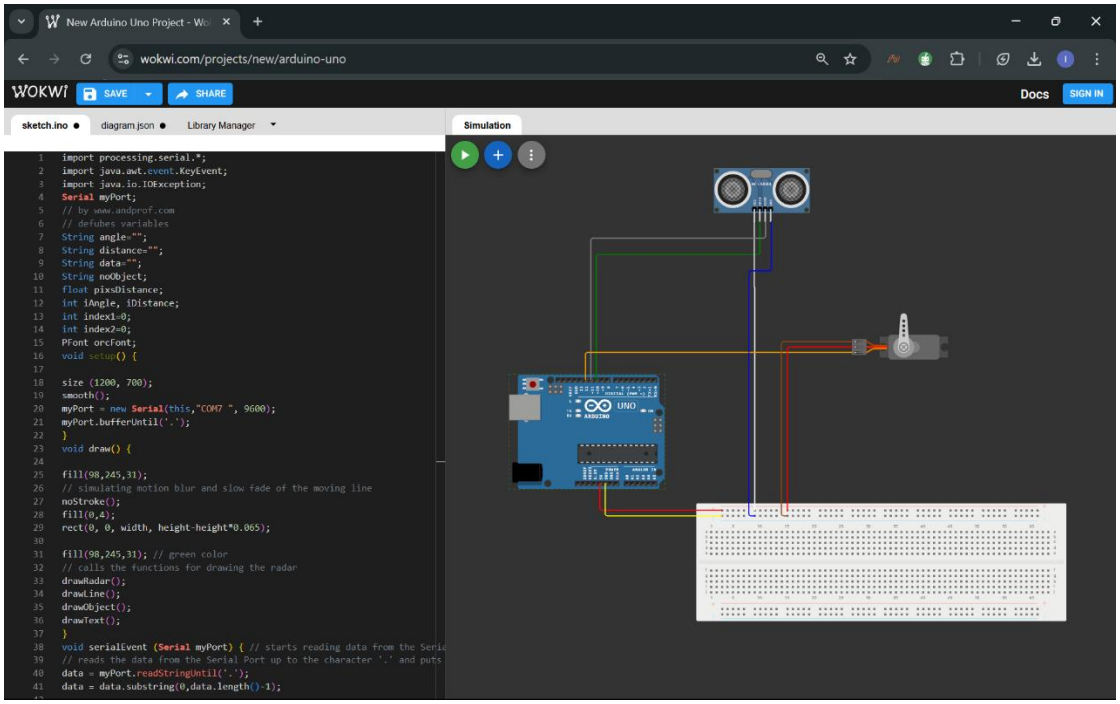
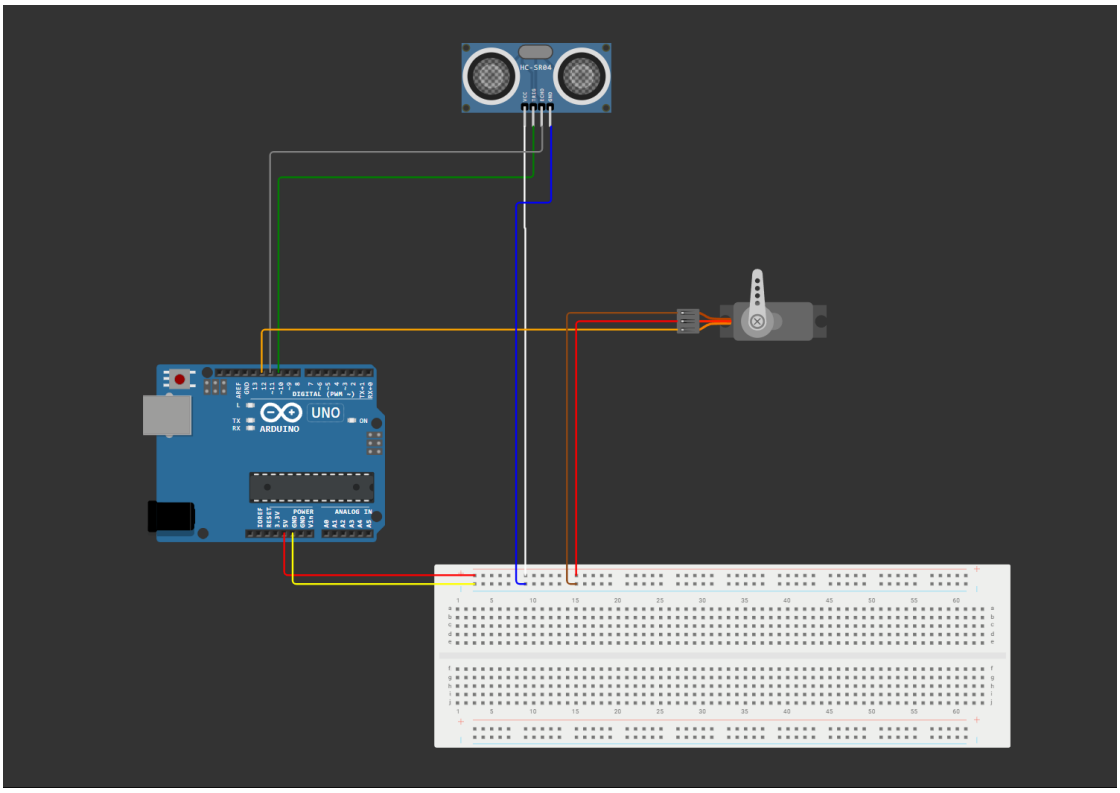
ADVAN



8.2. Simulation Screenshot

A simulation of the radar system was created using Wokwi to ensure proper wiring and behavior before deployment.





8.3. Live Demonstration Video

To showcase the functionality of this project, a video demonstration has been recorded and uploaded to Google Drive. The video illustrates the servo motor scanning motion, object detection via the ultrasonic sensor, and real-time radar visualization in Processing.

You can view the documentation for this project through the following link:
Click to view the documentation video

9. Conclusion

This project successfully demonstrated the construction and working of a basic object-detection radar system using Arduino and Processing. It combined electronic hardware and software simulation to create a real-time scanning and visualization system. The project provides a strong foundation for students, hobbyists, or researchers interested in embedded systems, IoT, or robotics.

The radar concept implemented here can be further developed with more advanced sensors such as LIDAR or Doppler radar, integrated into wireless communication networks, or connected to a cloud-based monitoring system for real-time surveillance.

10. Future Work and Enhancements

- Replacing the ultrasonic sensor with LIDAR for more accurate measurements.
- Using an ESP32 board for Wi-Fi-enabled real-time data transmission.
- Integrating object tracking algorithms for intelligent detection.
- Deploying the radar system in real-life environments such as warehouses or borders.
- Creating a mobile application for remote monitoring.

11. References

- Arduino Documentation (https://www.arduino.cc/en/Guide)
- Processing Language Reference (https://processing.org/reference/)
- Wokwi Simulator (https://wokwi.com)
- HC-SR04 Datasheet
- SG90 Servo Motor Datasheet