OBJECT DETECTION RADAR

A MINI-PROJECT REPORT

Submitted by

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in partial fulfilment of the award of the degree

of

BACHELOR OF ENGINEERING

IN

COMPUTER SCIENCE AND ENGINEERING

RAJALAKSHMI ENGINEERING COLLEGE, CHENNAI

RAJALAKSHMI ENGINEERING COLLEGE, CHENNAI

An Autonomous Institute

CHENNAI

APRIL 2024

BONAFIDE CERTIFICATE

Certified that this project **"OBJECT DETECTION RADAR"** is the bonafide work of "**JOTHIPRASAD D (210701099) and JEFFREY JESUDASAN R (210701092)"** who carried out the project work under my supervision.

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INTERNAL EXAMINER **EXTERNAL EXAMINER**

ACKNOWLEDGEMENT

We express our sincere thanks to our beloved and honourable chairman **MR. S. MEGANATHAN** and the chairperson **DR. M. THANGAM MEGANATHAN** for their timely support and encouragement.

We are greatly indebted to our respected and honourable principal **Dr. S.N. MURUGESAN** for his able support and guidance.

No words of gratitude will suffice for the unquestioning support extended to us by our head of the department **Dr. P. Kumar, M.E., Ph.D.** for being ever supporting force during our project work.

We also extend our sincere and hearty thanks to our internal guide **Dr. N. Duraimurugan, M.E, Ph.D,** for his valuable guidance and motivation during the completion of this project.

Our sincere thanks to our family members, friends and other staff members of information technology.

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LIST OF ABBREVIATION

ABBREVIATION	ACCRONYM
IoT	Internet of Things
GSM	Global System of Mobile Communications
SMS	Short Message Services
CRC	Cycle Redundancy Check
USB	Universal Serial Bus
MHz	Megahertz

ABSTRACT

Today, the demand for effective remote object detection and notification systems is increasing due to the ever-expanding range of applications in various fields. This Project presents an innovative solution that uses radar technology with Arduino microcontrollers to implement a comprehensive system that can not only detect objects, but also quickly send SMS messages when detected. The integration of radar technology with Arduino microcontrollers is a significant step forward, providing a cost-effective and versatile approach to remote sensing and communication.The proposed system seamlessly integrates a radar sensor module on an Arduino board that is programmed to interpret radar signals and activate an alarm protocol when objects are detected within a predefined proximity range. This integration enables real-time monitoring of the surrounding environment, enabling the rapid detection of objects such as intruders, vehicles or obstacles. Upon detection, the Arduino triggers the Global System for Mobile (GSM) module to begin sending text messages to selected recipients, ensuring timely awareness and response to detected objects.The key factor of the proposed system is its versatility and suitability for different applications. Whether used for security and surveillance, environmental monitoring or industrial automation, the system offers unparalleled flexibility to meet specific needs and requirements. In addition, the use of open source hardware and software components such as Arduino improves accessibility and facilitates widespread adoption, especially in resource-constrained environments.This Project provides a comprehensive overview of the hardware, including the radar sensor, Arduino microcontroller and GSM module, as well as detailed explanations of the software algorithm developed for efficient data processing and SMS delivery. The test results show the effectiveness and reliability of the proposed system to detect various objects and quickly notify users via text messages.

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

The integration of radar technology and Arduino microcontrollers offers a promising way to improve remote target detection and notification systems. This paper explores the development of a system that combines radar detection capabilities with SMS notification functionality through Arduino programmability. Using these technologies, the system aims to provide real-time target detection and rapid notification via text message, providing a versatile solution for a variety of applications.

1.2 SCOPE OF THE WORK

This project focuses on the development and implementation of a radar-based object detection system integrated with Arduino microcontrollers to enable real-time detection and SMS notification functions. The scope includes system planning, hardware, programming and testing phases. Key considerations include choosing a radar sensor, programming the Arduino to interpret the signal and send text messages, and testing to evaluate the performance of the system to detect various targets and effectively notify users.

1.3 PROBLEM STATEMENT

Existing methods of object detection lack the real-time notification feature, which somehow decreases their efficiency in responding timely. Besides, most of the existing notification systems consist of a highly complex and expensive infrastructure. This project addresses the challenges by developing a radar-based detection system integrated with Arduino microcontrollers for fast, cost-effective target detection with instant SMS notification. The system aims to bridge the gap between detection and notification by facilitating timely detection and response to detected objects in various applications.

1.4 AIM AND OBJECTIVES OF THE PROJECT

The goal of this project is to develop a radar detection system integrated with Arduino microcontrollers that enables real-time detection of objects and quick SMS notification. By combining radar technology with the flexibility of Arduino, the goal is to create a solution that bridges the gap between detection and notification, making it easy to detect and respond to detected objects in a variety of applications.

The objectives of the project are to design and assemble a radar detection system, develop an Arduino programming code to interpret signals and trigger an alarm, integrate GSM modules into SMS notifications, implement a user-friendly interface for configuration, conduct thorough testing, optimize performance and reliability , and document the process for later use and improvement.

CHAPTER 2

LITERATURE SURVEY

This [1] research investigates the use of multiple sensor triangulation to go beyond simple distance measuring when utilizing ultrasonic sensors in industrial settings. Through raw measurement data analysis, the system seeks to offer angle and distance information for objects that are detected. Optimizing sensor count, configuration, and algorithm design is the main goal in order to improve object detection and tracking. The practical aspects like as dependability and cost-effectiveness are also discussed to illustrate the influence and viability in the actual world.

This [2] research delves into the application of Machine Learning (ML) methods for Non-Destructive Evaluation (NDE) in the aerospace sector, with a particular emphasis on flaw detection in Carbon Fibre Reinforced Plastics (CFRPs). Using actual data from an experimental setup designed to imitate industrial situations, it contrasts machine learning models, statistical techniques, and conventional amplitude thresholding procedures. Machine learning (ML) models outperform conventional techniques, potentially improving the efficiency and accuracy of fault detection in CFRPs.

The [3] paper presents a novel solution to the problem of precisely identifying exterior pipeline leaks in petrochemical facilities. In order to improve leak detection and create a real-time monitoring system, it suggests utilizing artificial intelligence (AI) to enhance an image/ultrasonic convergence camera system. By using deep learning techniques that are trained on data from petrochemical plants, the system is able to locate gas leaks with greater precision.. All things considered, the study offers a viable way to improve pipeline leak detection through the use of AI algorithms and cutting-edge imaging technologies.

The [4] study tackles the problem of effectively identifying surface problems and wear in railways as well as rail flaws and artifacts. Because of their inaccuracy and length, traditional visual inspection methods have prompted research into deep learning approaches for better railway monitoring and maintenance. The goal of the project is to compare several deep-learning models using ultrasonic image data in order to create a structured model for identifying railway problems. The study assesses the efficacy and feasibility of rail indication identification from ultrasonic data using picture classification and object detection techniques.

The [5] paper provides a thorough analysis of the use of ultrasonic technology in lithium-ion batteries, addressing issues with fault diagnosis, defect identification, and battery state estimation that arise from the inability to assess internal battery states directly. It describes the current state, approaches, and difficulties in defect and fault diagnosis as well as the fundamentals of ultrasonic technology, including detecting techniques and methodologies, technical approaches, problems, and solutions for battery state estimate.

CHAPTER 3

SYSTEM SPECIFICATIONS

3.1 HARDWARE SPECIFICATIONS

Processor	:	AMD Ryzen 9
Memory Size	:	256 GB (Minimum)
HDD	:	40 GB (Minimum)

3.2 SOFTWARE SPECIFICATIONS

Operating System	:	Windows 11
Application	:	Arduino, Processing
Language	:	Python

3.3 COMPONENTS

Sensor	:	Ultrasonic Sensor
Board	:	Arduino Uno
Actuator	:	SG90 Micro Servo Motor
Light	:	RGB LED
Sound	:	Piezo Buzzer
Communication	:	Sim800L GSM

CHAPTER 4

MODULE DESCRIPTION

Arduino UNO:

The Arduino UNO is a popular microcontroller board known for its versatility and ease of use for electronic prototyping and DIY projects. It has an ATmega328P microcontroller, 14 digital I/O pins, 6 analog inputs, a 16 MHz crystal oscillator, a USB port and a power port, making it suitable for a wide range of applications. With a large community of enthusiasts and abundant online resources, Arduino UNO is an accessible platform for both beginners and experienced programmers to experiment with electronics, programming and automation, fostering innovation and creativity in the maker community.

Servo Motor:

A servo motor is a kind of rotary actuator that provides a very good platform for controlling angular position, velocity, and acceleration. It constitutes a motor and a gearbox, together with a feedback control system. Unlike standard DC motors, servo motors use a closed-loop control mechanism, most often a potentiometer or an encoder, to provide position feedback from the motor. This creates a feedback loop in the operation of the servo motor, where it accurately keeps its position or follows a designated trajectory. Applications for servo motors include robots, remote-controlled vehicles, and industrial automation, among many others. They are the component of many electromechanical systems due to their compact size and a high torque-to-weight ratio with precision positioning capabilities.

Ultrasonic Sensor:

The ultrasonic sensor is a device used for distance measurement, proximity detection, and object avoidance in various applications. Operating on the principle of emitting high-frequency sound waves and measuring the time it takes for the waves to bounce back after hitting an object, ultrasonic sensors can accurately determine distances with millimeter-level precision.

These sensors typically consist of a transmitter, which emits ultrasonic pulses, and a receiver, which detects the reflected waves. By analyzing the time delay between transmission and reception, the sensor calculates the distance to the target object. Ultrasonic sensors find widespread use in robotics, automotive parking systems, industrial automation, and even in home security applications.

Buzzer:

A buzzer is The device that produces sound signals when an electric current passes through it. It usually consists of a coil of wire wound over a magnetic core, a vibrating membrane, and a housing to amplify and direct the sound. When an electric current passes through the coil, it creates a magnetic field that attracts or repels the membrane, causing it to vibrate and produce sound waves. The frequency, volume and duration of the buzzer sound may vary depending on the design and purpose of the application. Buzzers are widely used in alarm systems, electronic devices and user interfaces to provide audio signals, alerts and feedback. Buzzer circuits can be simple - requiring only a power supply and a switch to activate them.

GSM Module:

The GSM module is a small electronic module that allows devices to communicate with other devices by means of cellular networks. The module allows these devices to send and receive data like voice calls, text messages, or SMS, and also grants internet connectivity on GSM networks. Usually, the GSM module has a slot for a SIM card that can be used for authentication on the network. It includes a radio transceiver and an antenna for establishing wireless communication with cellular towers. GSM modules have many applications, including remote monitoring, telemetry, and IoT devices, providing reliable, long-range communication ability. They are an essential component for providing connectivity and remote control in many industries and application.

CHAPTER 5

SYSTEM DESIGN

5.1 ARCHITECTURE DIAGRAM

An architecture diagram is a graphical representation of a set of concepts, that are part of an architecture, including their principles, elements and components

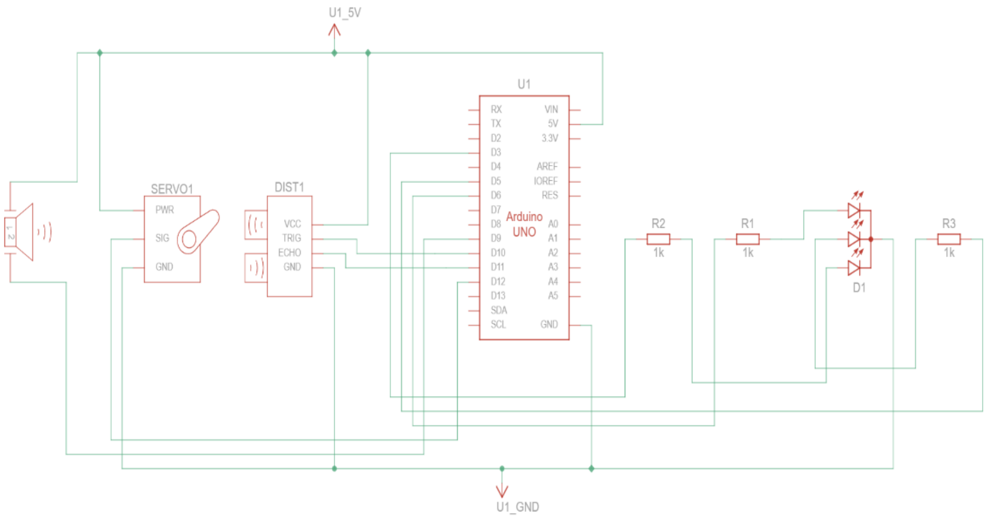

Figure 5.1: Architecture Diagram

From the above Figure 5.1, the architecture of the system is well understood.

5.2 FLOW CHART

A flowchart is a type of diagram that represents an algorithm, workflow or process. The flowchart shows the steps as boxes of various kinds, and their order by connecting the boxes with arrows. This diagrammatic representation illustrates a solution model to a given problem.

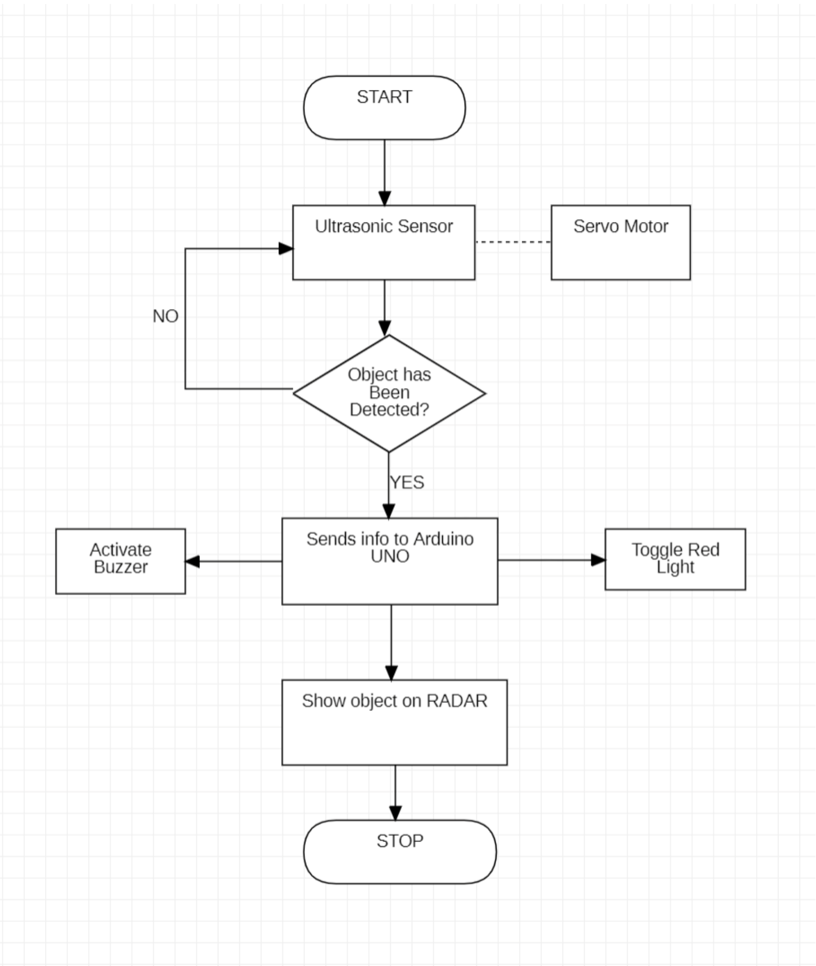

Figure 5.2 Flow Chart

From the above Figure 5.2, the workflow of Flow chart Diagram has been shown

5.3 CIRCUIT DIAGRAM

The connections and parts of an electronic circuit are shown graphically in the circuit diagram. Using standardized symbols and terminology, it acts as a blueprint for constructing and comprehending the functionality of the circuit by showing how the components are arranged, connected, and related to one another

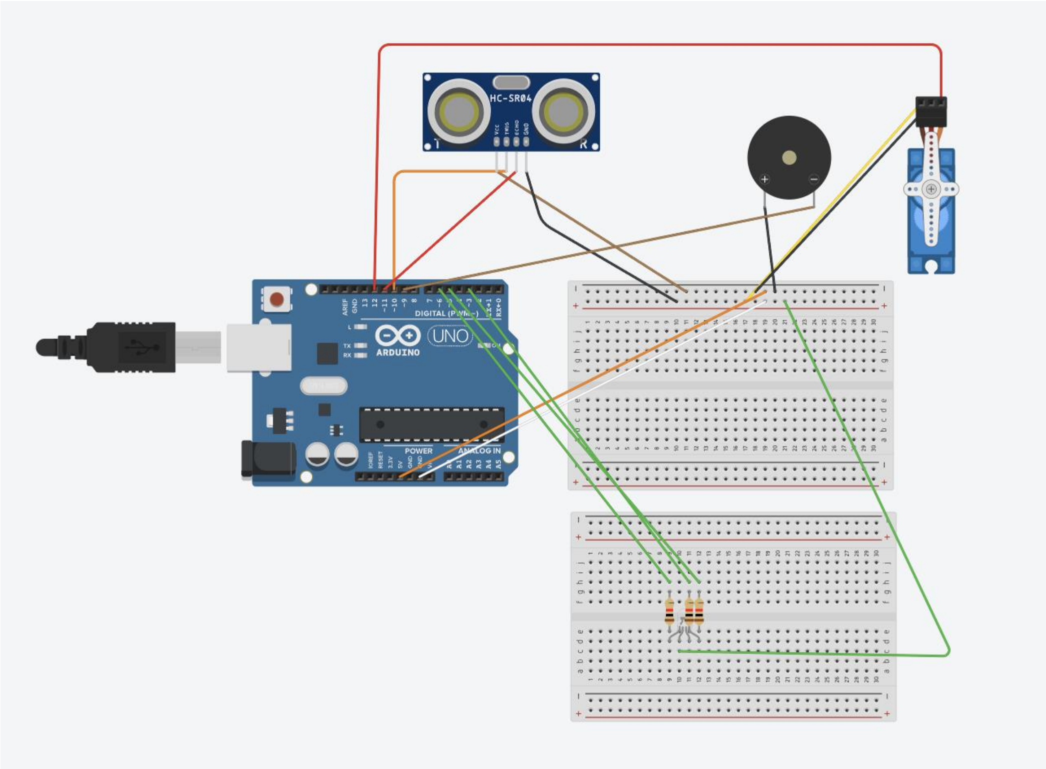

Figure 5.3: Circuit Diagram

The above figure 5.3 represents the Circuit Diagram

CHAPTER 6

SAMPLE CODING

1. Arduino

```
#include <Servo.h>
#include <SoftwareSerial.h>

const int trigPin = 10;
const int echoPin = 11;
const int buzzerPin = 9;

long duration;
int distance;
Servo myServo;

SoftwareSerial sim800l(7, 8);

void setup() {
    pinMode(trigPin, OUTPUT);
    pinMode(echoPin, INPUT);
    pinMode(buzzerPin, OUTPUT);
    Serial.begin(9600);
    sim800l.begin(9600);

   sendATcommand("AT", 1000);
   sendATcommand("AT+CMGF=1", 1000);
   myServo.attach(12);
   }

   void loop() {
   for (int i = 15; i <= 165; i++) {
   myServo.write(i);
   delay(30);
   distance = calculateDistance();

   Serial.print(i);
   Serial.print(",");
   Serial.print(distance);
```

```
 if (distance < 10) {
digitalWrite(buzzerPin, HIGH);
sendSMS("Object Detected on " + String(distance) + " cm");
} else {
digitalWrite(buzzerPin, LOW);
}
}
for (int i = 165; i > 15; i--) {
myServo.write(i);
delay(30);
distance = calculateDistance();
Serial.print(i);
Serial.print(",");
Serial.print(distance);
Serial.print(".");

if (distance < 10) { // Modify the threshold as needed
digitalWrite(buzzerPin, HIGH);
sendSMS("Object Detected on " + String(distance) + " cm");
} else {
digitalWrite(buzzerPin, LOW);
}
}
}

String sendATcommand(char* ATcommand, unsigned int timeout) {
String response = "";
sim800l.println(ATcommand);
long int time = millis();
while ((time + timeout) > millis()) {
while (sim800l.available()) {
        char c = sim800l.read();
        response += c;
 }
 }
  return response;
}

void sendSMS(String message) {
  sim800l.println("AT+CMGS=\"+1234567890\"");
  delay(1000);
  sim800l.println(message);
  delay(100);
  sim800l.println((char)26);
```

```
int calculateDistance() {
  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);
  duration = pulseIn(echoPin, HIGH);
  distance = duration * 0.034 / 2;
  return distance;
}
```

2. Processing

```
import processing.serial.*; // imports library for serial communication
import java.awt.event.KeyEvent; // imports library for reading the data from the serial port
import java.io.IOException;
Serial myPort; // defines Object Serial
// defubes variables
String angle="";
String distance="";
String data="";
String noObject;
float pixsDistance;
int iAngle, iDistance;
int index1=0;
int index2=0;
PFont orcFont;
void setup() {

  size (1200, 700); // ***CHANGE THIS TO YOUR SCREEN RESOLUTION***
  smooth();
  myPort = new Serial(this,"COM3", 9600); // starts the serial communication
        myPort.bufferUntil('.'); // reads the data from the serial port up to the character '.'.
  So actually it reads this: angle,distance.
  }
  void draw() ;
  fill(98,245,31);
```

```
noStroke();
fill(0,4);
 rect(0, 0, width, height-height*0.065);

 fill(98,245,31); // green color
// calls the functions for drawing the radar
drawRadar();
drawLine();
drawObject();
drawText();
}
void serialEvent (Serial myPort) { // starts reading data from the Serial Port
// reads the data from the Serial Port up to the character '.' and puts it into the String variable "data".
data = myPort.readStringUntil('.');
data = data.substring(0,data.length()-1);

index1 = data.indexOf(","); // find the character ',' and puts it into the variable "index1"
        angle= data.substring(0, index1); // read the data from position "0" to position of the variable index1 or thats the value of the angle the Arduino Board sent into the Serial Port
 distance= data.substring(index1+1, data.length()); // read the data from position "index1" to the end of the data pr thats the value of the distance

// converts the String variables into Integer
 iAngle = int(angle);
iDistance = int(distance);
}
void drawRadar() {
pushMatrix();
translate(width/2,height-height*0.074); // moves the starting coordinats to new location
 noFill();
strokeWeight(2);
 stroke(98,245,31);

arc(0,0,(width-width*0.0625),(width-width*0.0625),PI,TWO_PI);
```

```
arc(0,0,(width-width*0.479),(width-width*0.479),PI,TWO_PI);
arc(0,0,(width-width*0.687),(width-width*0.687),PI,TWO_PI);
 // draws the angle lines
 line(-width/2,0,width/2,0);
line(0,0,(-width/2)*cos(radians(30)),(-width/2)*sin(radians(30)));
line(0,0,(-width/2)*cos(radians(60)),(-width/2)*sin(radians(60)));
line(0,0,(-width/2)*cos(radians(90)),(-width/2)*sin(radians(90)));
line(0,0,(-width/2)*cos(radians(120)),(-width/2)*sin(radians(120)));
 line(0,0,(-width/2)*cos(radians(150)),(-width/2)*sin(radians(150)));
line((-width/2)*cos(radians(30)),0,width/2,0);
popMatrix();
}
void drawObject() {
pushMatrix();
translate(width/2,height-height*0.074); // moves the starting coordinats to new location
 strokeWeight(9);
stroke(255,10,10); // red color
            pixsDistance = iDistance*((height-height*0.1666)*0.025); // covers the distance
from the sensor from cm to pixels
// limiting the range to 40 cms
if(iDistance<40){
// draws the object according to the angle and the distance
            line(pixsDistance*cos(radians(iAngle)),-
pixsDistance*sin(radians(iAngle)),(width-width*0.505)*cos(radians(iAngle)),-(width-
width*0.505)*sin(radians(iAngle)));
}
popMatrix();
}
void drawLine() {
pushMatrix();
strokeWeight(9);
stroke(30,250,60);
translate(width/2,height-height*0.074); // moves the starting coordinats to new location)


 popMatrix();
}
```

```
void drawText() { // draws the texts on the screen

pushMatrix();
if(iDistance>40) {
noObject = "Out of Range";
}
 else {
 noObject = "In Range";
 }
fill(0,0,0);
noStroke();
 rect(0, height-height*0.0648, width, height);
fill(98,245,31);
textSize(25);

text("10cm",width-width*0.3854,height-height*0.0833);
text("20cm",width-width*0.281,height-height*0.0833);
text("30cm",width-width*0.177,height-height*0.0833);
text("40cm",width-width*0.0729,height-height*0.0833);
textSize(40);
text("RADAR ", width-width*0.875, height-height*0.0277);
text("Angle: " + iAngle +" °", width-width*0.48, height-height*0.0277);
text("Dist.: ", width-width*0.26, height-height*0.0277);
if(iDistance<40) {
text("        " + iDistance +" cm", width-width*0.225, height-height*0.0277);
}
textSize(25);
fill(98,245,60);
        translate((width-width*0.4994)+width/2*cos(radians(30)),(height-height*0.0907)-
width/2*sin(radians(30)));
rotate(-radians(-60));

text("30°",0,0);
```

```
rotate(-radians(-30));
text("60°",0,0);
resetMatrix();
translate((width-width*0.507)+width/2*cos(radians(90)),(height-height*0.0833)-width/2*sin(radians(90)));
rotate(radians(0));
text("90°",0,0);
resetMatrix();
translate(width-width*0.513+width/2*cos(radians(120)),(height-height*0.07129)-width/2*sin(radians(120)));
rotate(radians(-30));
text("120°",0,0);
resetMatrix();
translate((width-width*0.5104)+width/2*cos(radians(150)),(height-height*0.0574)-width/2*sin(radians(150)));
rotate(radians(-60));
text("150°",0,0);
popMatrix();
}
```

CHAPTER 7

SCREEN SHOTS

1.DEVICE

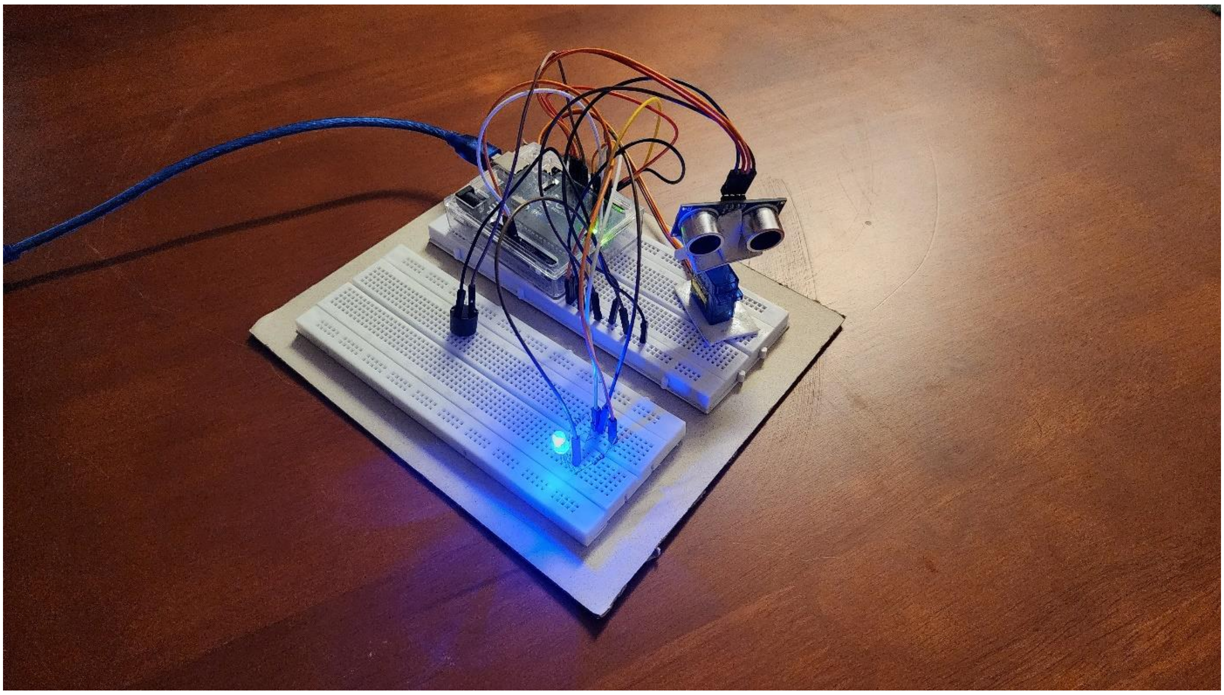

Fig 7.1: Device

2. RADAR

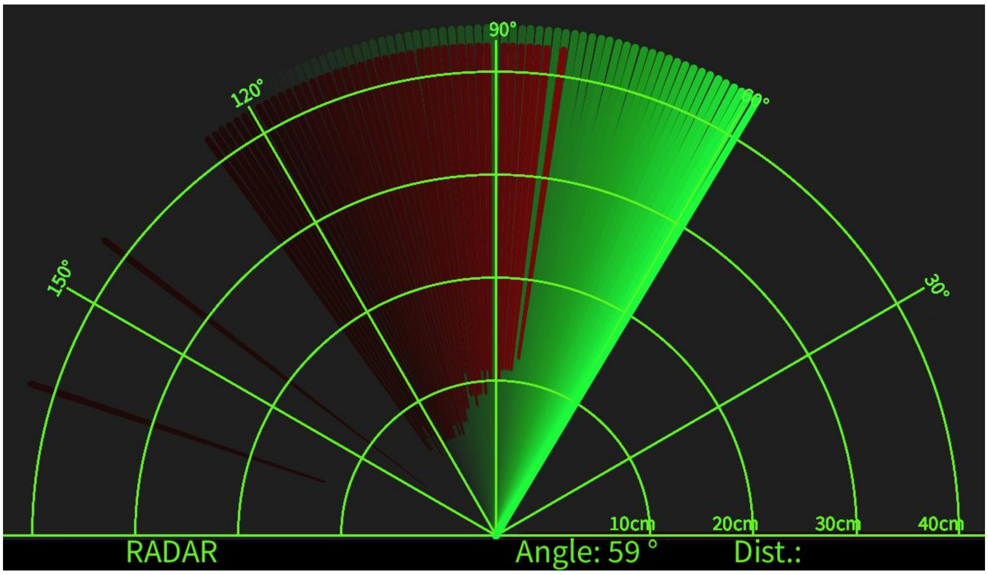

Fig 7.2: Radar

CHAPTER 8

CONCLUSION AND FUTURE ENHANCEMENT

In conclusion, the integration of radar detection with Arduino microcontrollers and GSM modules provides an effective solution for real-time target detection and instant SMS notification. Through this project, we have successfully developed a system that can detect targets using radar technology and trigger SMS messages using Arduino microcontrollers. This system offers significant opportunities to improve security, surveillance and remote sensing applications by providing timely awareness of and response to identified targets. The versatility, reliability and cost-effectiveness of this solution make it suitable for many applications, from home automation to industrial control.

Future improvements may be considered to further improve the functionality and usability of the system. Integration with additional sensors such as cameras or infrared sensors can improve target detection accuracy and enable multi-mode detection capability. In addition, applying machine learning algorithms to object recognition can allow the system to distinguish between different types of objects and trigger context-specific responses. Additionally, enhancing the user interface with a mobile app or web-based control panel can provide users with even more intuitive controls and monitoring features. Finally, exploring alternative communication protocols such as LoRa or NB-IoT can extend the reach and reliability of the system, especially in remote or rural areas with limited cellular network coverage. Overall, these upcoming improvements can further improve the efficiency and versatility of a radar detection system integrated with Arduino and GSM technology.

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