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RADAR SYSTEM USING ARDUINO

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ABSTRACT: An electrical instrument called a radar uses electromagnetic waves to measure an object's height, range, direction, or speed, whether it is moving or stationary. On the other hand, ultrasonic radar uses ultrasonic waves rather than electromagnetic radiation. Ultrasonic radar is thought to be mostly used for security applications, object identification, and robotics avoidance systems because to its low power consumption, low cost, and ease of installation. The design and use of ultrasonic radar for measuring distance is presented in this article. A servo motor, an Arduino board serving as a controller, an ultrasonic sensor, and a Java program make up the design. A statistical examination of the distance error between the barriers and the radar is used to determine how successful the suggested design is. The results obtained for every kind of barrier are graphed and presented to demonstrate that the suggested design may achieve extremely tiny errors.

Index terms **: Radar, Ultrasonic sensor, Breadboard**

INTRODUCTION

Radar, short for Radio Detection and Ranging, is a technology that has long been the stuff of science fiction and military applications. It utilizes radio waves to measure the distance, speed and direction of objects, forming the foundation of modern navigation, weather forecasting, and security systems. Until recently, building a radar system was a formidable challenge reserved for experts in the field, but Arduino has reshaped this landscape.

Imagine having the ability to peer into the unseen, to detect and track objects in your surroundings with the precision and insight of advanced radar technology. Now, envision achieving this feat not through complex and costly equipment but through the ingenuity of Arduino, a microcontroller platform celebrated for its accessibility and versatility. Welcome to the realm of Arduino-based radar systems, where innovation knows no bounds.

This introduction embarks on a journey into the fascinating world of Arduino-powered radar technology, where we explore the fusion of cutting-edge radar principles with the user-friendly Arduino ecosystem. Together, we will delve into the fundamental concepts, components, and step-by-step procedures needed to create your very own radar system using Arduino.

We can produce radio waves and detect the exact amount of time it takes for them to return after bouncing off adjacent objects by using ultrasonic or microwave sensors. With the help of intelligent signal processing and programming, Arduino transforms this data into insightful knowledge that lets you find, identify, and see items around you. Imagine an Arduino-based radar system that creates a real-time depiction of items it detects on a display mounted on a motorized platform that is constantly scanning the environment.

Such an invention has exciting and far-reaching ramifications. The possibilities are endless when it comes to creating object detecting systems, improving home security, helping robots and drones navigate autonomously, or just satisfying your curiosity.

HARDWARE AND SOFTWARE REQUIREMENT

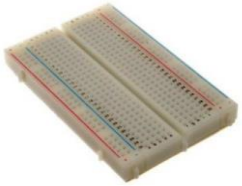
An open-source, free microcontroller is called Arduino. It can communicate with many components thanks to its input and output digital and analog pins. Our interfaced ultrasonic sensor functions similarly to the radar's central component. Next, the output LCD (16*2 module) will be shown. You can use it in read-only or write-only mode. We've used write mode on it for our purposes. It features an enable pin, which serves as a notification.

- Arduino UNO board :
  The Arduino UNO microcontroller board is built around the ATmega328. It includes six PWM-capable digital output/input pins among its fourteen total pins. It also has six analog inputs, a 16 MHz ceramic resonator, a USB port, a power connector, an ICSP header, and a reset button. It comes with everything required to support the microcontroller; all you have to do to get started is connect it via a USB connection, an AC-to-DC converter, or a battery to a computer.

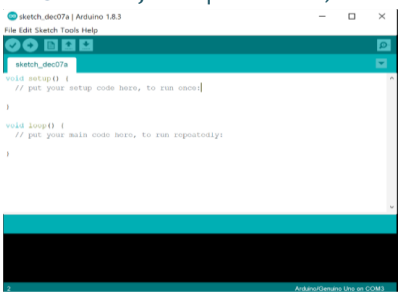
- Ultrasonic sensor:
  With a range accuracy of up to 3mm, this affordable HC-SR04 ultrasonic sensor offers non-contact measuring capabilities between 2 and 400 cm. A control circuit, a receiver, and an ultrasonic transmitter make up each sensor. The four pins that should be most concerned are GND (ground), VCC (power), Trig (trigger), and Echo (receive). Depending on the application, this sensor gives you the extra control circuitry to stop inconsistent "Bouncy" data.

- Servo Motor :
  A motor with extremely precise rotation is called a servo motor. Typically, this motor has a control circuit that gives you input on the motor shaft's present position. With this feedback, the servo motors can rotate precisely. A servo motor can be used to spin an item at a given distance or angle. servo motor goes through a servo mechanism.

- Breadboard:
  A solderless tool called a breadboard is used to create temporary prototypes of electronics and circuit designs. The majority of electrical components in circuits may be linked to one another by simply putting their terminals into the holes and connecting via wires where suitable. Metal strips go below the breadboard and connect the holes on top of the board.



- Arduino IDE:
  The Arduino Software (IDE), also known as the Arduino Integrated Development Environment, consists of a text editor for writing code, a message area, a text terminal, a toolbar with buttons for basic operations, and a number of menus. In order to upload programs and interact with the Arduino hardware, it establishes a connection with it.



DESIGN AND INPLEMENTATION OF THE RADAR SYSTEM

The Radar project's development life cycle includes a number of steps, including designing various components, testing them, implementing them, and testing the complete system. These actions can be divided into the subsequent phases.

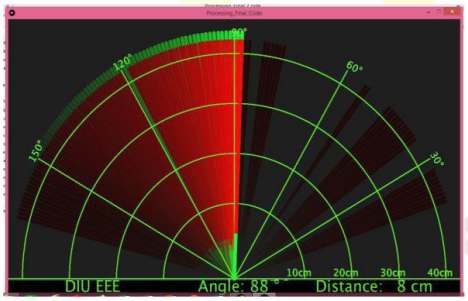
1) Hardware System Design.
2) Hardware Circuit Design.
3) Hardware System implementation. Radar system using Arduino
4) Hardware unit testing.
5) GUI System Design.
6) GUI System Implementation.
7) GUI unit testing.
8) Entire system integration.
9) Entire system testing.

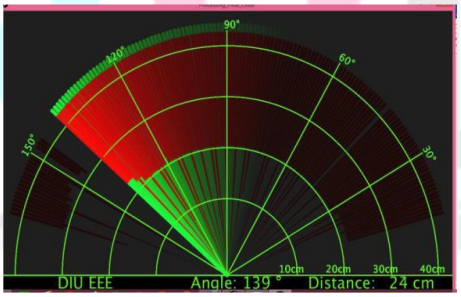
WORKING

Determining the distance, location, and speed of an obstruction placed at a given distance from the sensor is the main goal of our design. With the assistance of servo motors, an ultrasonic sensor rotates to deliver ultrasonic waves in different directions. This wave travels through the air and is reflected back after colliding with an item. The sensor detects this wave once more, analyzes its characteristics, and outputs information on factors like object position and distance to the screen. The Arduino IDE is used to write code, transfer code within Arduino, and enable us to detect the position or angle of a servo motor. This information is transmitted over the serial port together with the distance covered by the closest item in the motor's path. The program known as processing displays the input/output and object range as the result of all of this labor. Because the ultrasonic sensor has to identify objects and their distance, it is implemented such that it is connected on top of the servo motor. The servo motor and ultrasonic sensor will be controlled by an Arduino microcontroller, which will also supply electricity to them both.

Distance and Angle Calculation:

Calculating angles and distances is the primary focus of our study. Our first goal was to create a radar that could only identify objects. We therefore believe that the distance and angle may be calculated with the use of additional tools. As proof of our claim, we provide two images.





Angle (Manual)	Angle (Radar)	Distance Measured by Scale	Distance Measured by Radar
88	88	8cm	9cm
142	139	24cm	24cm

APPLICATION

This Radar System have various applications for security purposes and it is mainly used for mapping.

• Use in the Air Force: It is employed in aircraft or aviation machinery that has a radar system installed to identify approaching objects. Readings of height are also calculated with it.

• Utilize in the Marine Industry: Ships and other marine vehicles also utilize this radar system. Large ships use it to measure the separation between themselves and other vessels; by doing so, the number of maritime accidents can be decreased by preventing collisions. It may also be used at ports to track or manage ship movements and determine how far away other ships are.

• Use in Meterology: Radar systems are also used by meteorologists to track or keep an eye on the wind. It is now a crucial piece of equipment for evaluating climates. As an illustration

RADAR ARDUINO CHALLENGES

- Sparse Sensing and Sparse Array Design in Radar
- Radar Waveform Optimization
- Cognitive Radar
- Machine Learning for Radar

FUTURE TRENDS

- Higher Resolution and Accuracy: Radar technology could continue to advance, enabling radar systems based on Arduino to achieve higher levels of resolution and accuracy in object detection and tracking.
- Integration with AI and Machine Learning: Arduino-based radar systems might leverage AI and patterns, leading to more sophisticated applications.
- Low-Power and Miniaturization: With a focus on energy efficiency and portability, future trends could involve designing radar systems using Arduino that are smaller in size and consume even less power.

CONCLUSION

This paper describes the design and implementation of a lab-scale radar system that makes use of an Arduino, a servo motor, and an ultrasonic sensor. The created system can read the angle of the event and the distance between barriers, converting this data into information that can be seen visually. The system performs comparably to other systems of a similar caliber since it reports obstacles in its route and gives an approximation of their range.

This technology would be highly useful in robotics object identification and avoidance systems or even intrusion detection systems for larger locations where it might not be cost-effective to deploy many units to offer sufficient coverage. The range of the employed ultrasonic sensor determines the system's range.

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