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IOT BASED ULTRASONIC RADAR SYSTEM USING ARDUINO

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ABSTRACT

Radar is an electronic device that uses electromagnetic waves to determine the height, distance and direction of objects. In contrast, ultrasonic radar uses ultrasonic waves instead of electromagnetic waves. Low power consumption, low cost and ease of use are considered the main features of ultrasonic radar, which can be used in many applications such as security purposes, research products and robot fashion. This work presents the design and application of ultrasonic radar for distance measurement. The design includes an ultrasonic sensor, an Arduino board as a controller and a servo motor.

I. INTRODUCTION

The Small Ultrasonic Radar System for Object Detection offers a new way to measure distance and detect objects using ultrasonic technology. The project aims to create a portable and cost-effective radar system that can detect objects at short and medium distances. The system uses an ultrasonic sensor to emit high-frequency sound waves and measure the time it takes for the sound to reflect off an object and return to the sensor. The microcontroller performs these measurements to calculate the distance between the sensor and the detected object. Thanks to careful programming and signal processing, radar systems can detect multiple objects simultaneously and instantly indicate their distance.

II. METHODOLOGY

Developing an ultrasonic radar system using an Arduino and an ultrasonic sensor involves a structured methodology to ensure a successful and reliable outcome.

The following steps describe the planning and implementation of the project:

1. Requirements Analysis: - Identify specific radar system requirements, including desired range, accuracy, and intended applications. This analysis drives the overall system design.
2. Component selection: - Select appropriate components such as an ultrasonic sensor capable of accurate distance measurement, an Arduino board for control and data processing, and a servo motor for directional scanning.
3. System Architecture Design: - Create a comprehensive system architecture that illustrates the connections and interactions between components. Define how the ultrasonic sensor communicates with the Arduino board and how the data is processed.
4. Arduino Programming: - Develop and optimize the Arduino code to read the data from the ultrasonic sensor, process the distance measurement and control the servo motor for directional scanning. Ensure efficient and reliable operation.
5. Component Integration: - Physically integrate selected components with proper wiring and connections in mind. Make sure the components work together smoothly.
6. Calibration and testing: - Calibrate the ultrasonic sensor to account for environmental factors. Conduct thorough testing to verify distance measurement accuracy and reliability in various scenarios.
7. Servo Motor Control: - Implement control mechanisms for the servo motor to enable directional sensing of the ultrasonic sensor. This improves the field of view of the radar system.

III. OBJECTIVE

The aim of this project is to:

1. Design and construct a compact ultrasonic radar system capable of detecting objects at short range.
2. Implement real-time feedback mechanisms to communicate object presence and distance information.
3. Ensure affordability and simplicity of system design and implementation.

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4. They provide adaptability for integration into various applications such as indoor navigation or small robotics.

SCOPE

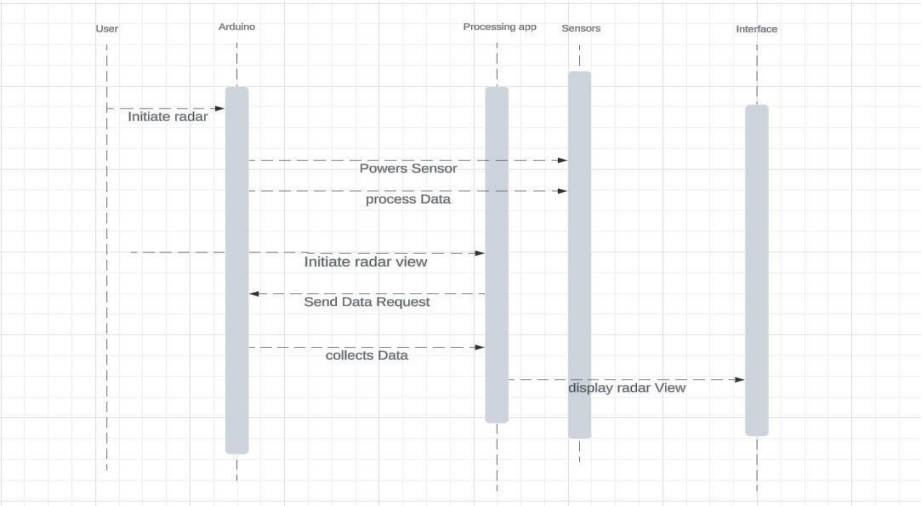
Functional Scope:

- Distance measurement: The project specifically focuses on accurate distance measurements using ultrasonic waves.
- Versatility: Explores the versatility of ultrasonic radar technology for a variety of applications.
- Security systems: Addresses the application of the system in security measures.
- Robotics Integration: Considers the integration of a radar system into robotic applications.
- Object Detection and Avoidance: The goal is to contribute to systems used for object detection and avoidance.

IV. PROJECT DESCRIPTION

The Ultrasonic Radar System project aims to create a sophisticated distance measurement solution using Arduino technology and ultrasonic sensors. The methodology includes a systematic approach to the design, implementation and integration of key components for an effective and reliable radar system. The ultrasonic sensor, the basic element of the system, emits ultrasonic waves and captures echoes for accurate distance calculation. The Arduino microcontroller serves as the brain of the system, processing the data from the sensor and controlling the servo motor for directional scanning. The servo motor adds a key feature that allows the radar to scan and detect objects at different angles, expanding its field of view. The principle of operation of our proposed system is connected with the following components, which are ultrasonic sensors connected to the digital input and output pin of the microcontroller (we chose Arduino). Then we have the servo motor which is also connected to the digital output and input pins. The two main parts of the ultrasonic sensor and the servo motor are connected at the same time, so when our servo motor rotates from 0 degrees to 180 degrees from the right side to the far left side, the motor will rotate near its axis. We use a computer screen to demonstrate the data (distance and angle) using a software called "Processing development Environment"

This project is in line with the advantages of ultrasonic radar technology with emphasis on low power consumption, economy and ease of implementation. The ultrasonic radar system is poised to find applications in security systems, robotics and object detection scenarios due to its versatility and accuracy.



System Sequence Diagram

Figure represents the system's sequence diagram. Here, it can be seen how the workflow in this radar system works. The sensor is going to sense the obstacle and determine the angle of incident and its distance from the radar. The servo motor is constantly rotating to and fro, hence making the sensor move. The data obtained is encoded and fed to the processing IDE which represents it on the screen. The results are displayed further in this paper. All these operations are done by Arduino microcontroller from the rotation of the servo, data collection from the sensor, feeding the data to the encoder to transferring it to the display.

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V. WORKING

The main purpose of our setup is to detect the position and speed difference of the problem at a certain distance from the sensor. The ultrasonic sensor rotates with the help of a servo motor and sends ultrasonic waves to different directions. These waves travel through the air and return to reflection after leaving some material. The wave is detected again by the sensor, its properties are analyzed and the output shows parameters such as distance and position of the object and is displayed on the screen. Arduino IDE is used to write code in Arduino and modify the code that allows us to find the position or angle of the servo motor and communicate with the nearest program through the serial port. The output of all this work is displayed in a software program called a process, which shows the input/output and product type. The use of the sensor can be an ultrasonic sensor mounted on top of the servo motor as it needs to detect the object and its distance. Arduino (microcontroller) will control the ultrasonic sensor and servo motor and can operate them through the microcontroller

EXPECTED OUTCOME

1. Distance Measurement Precision:
- Achieve accurate and reliable distance measurements using ultrasonic waves.
- Implement algorithms to enhance precision and reduce measurement errors.
2. Low Power Consumption:
- Design the system to operate efficiently with minimal power consumption.
- Employ power-saving modes when the radar is idle to enhance energy efficiency.
3. Cost-Effective Solution: -
- Develop a radar system that is cost-effective and utilizes readily available components.
- Explore open-source software and affordable hardware options to minimize expenses.
4. Ease of Implementation:
- Provide a user-friendly design that allows easy setup and integration.
- Develop documentation and guides for straightforward implementation by users.
5. Versatile Applications:
- Ensure the radar system's adaptability for various applications, such as security, robotics, and object detection.
- Design the system to be easily customizable for different use cases.
6. Reliability and Stability:
- Rigorously test the radar system for reliability under various environmental conditions.
- Implement error-handling mechanisms to maintain system stability

VI. DISCUSSION AND RESULT

In this research paper we've mentioned that our system is designed to include the following components together with a servo- motor, an ultrasonic sensor and a microcontroller (Arduino). The device's objective is to tune the distance and angle of the object and to symbolize this information graphically, meaning its output ought to be in graphical shape to be able to be represented through processing software. We can have a concept of the performance of this radar with the aid of trying out items at distinctive ranges and watching how fast or easily it detects an item that it reveals in a manner and offers us a predicted variety of the obstacle . Following figure shows the effects of the reveal screen of our layout while the sensor rotates through the place and detects obstacles in the manner. The red location suggests the presence of limitations and underneath the attitude of incident and distance is being displayed

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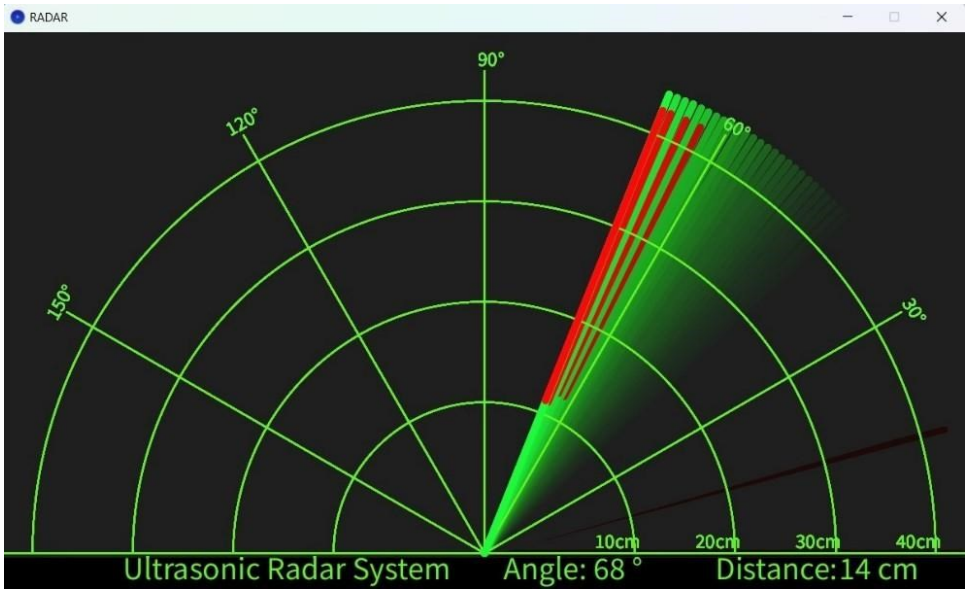
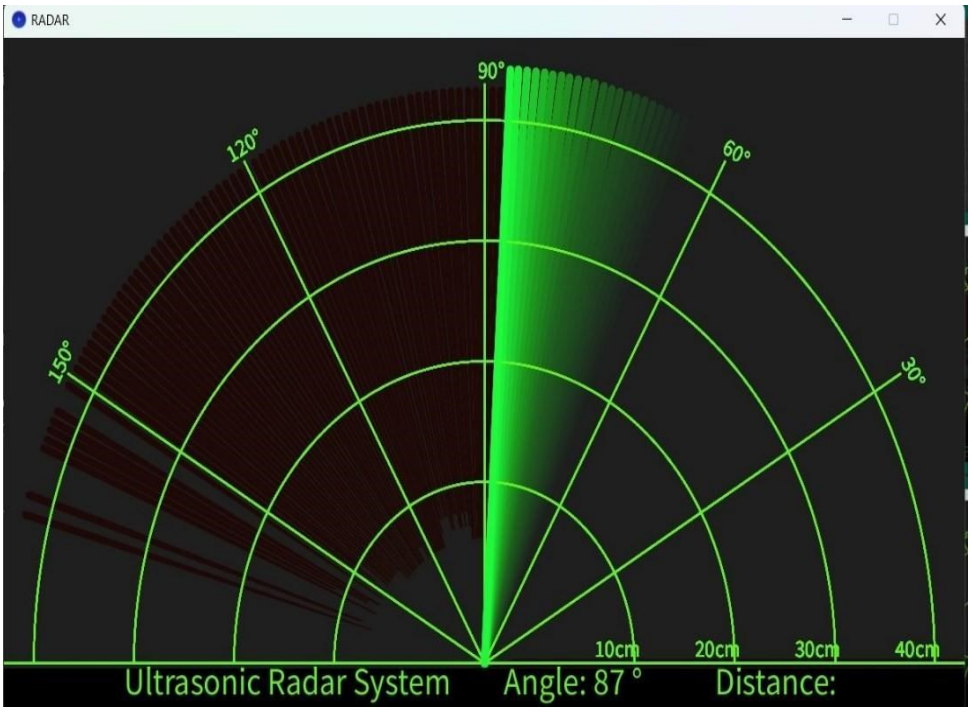
Testing of the system:



Processing IDE Screen displaying output of the system which we tested by placing objects



Processing IDE Screen displaying output of the system which we tested by placing no object

VII. APPLICATIONS

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

1. APPLICATION IN AIR FORCE: It is used in airplanes or aircraft machines which have implemented a radar system in it to detect the objects that come in a way. It is also used to calculate height readings.
2. APPLICATION IN MARINE: This radar system is also used in ships or marine. It is implemented on big ships to calculate the distance of other boats or ships, with the help of this sea accidents can also be reduced by not colliding. It can also be implemented on ports to see the distance of other ships and to monitor or control the ship movements.
3. APPLICATION IN METEOROLOGY: Meteorologists also use radar systems to track or monitor the wind. It has become an important equipment for climate testing. For example to detect tornadoes, storms

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VIII. RESOURCE AND LIMITATION

Resources:

1. Ultrasonic Sensor: Serves as the core component for distance measurement, emitting and receiving ultrasonic waves.
2. Arduino Board: Acts as a programmable controller, enabling interfacing with the ultrasonic sensor and executing control logic.
3. Servo Motor: Enhances the radar system's scanning capability, allowing effective detection of objects within the environment.
4. Java Application: Provides a platform-independent interface for user interaction and efficient data processing.

Limitations:

1. Range Constraints: The effective range of the radar system may be limited by factors such as sensor capabilities and environmental conditions.
2. Influence of Obstacles: Ultrasonic waves can be affected by obstacles, potentially impacting the accuracy of distance measurements.
3. Environmental Factors: Certain materials and weather conditions may pose challenges to the reliability of ultrasonic wave-based measurements.
4. Accuracy at Longer Distances: The accuracy of distance measurements might decrease at longer distances from the sensor.
5. Processing Limitations: The performance of the system could be constrained by the processing capabilities of the Arduino board, limiting the complexity of algorithms and real-time processing.

IX. CONCLUSION

In this article, a laboratory-scale radar system is designed and implemented using Arduino, servo motors and ultrasonic sensors. The system can read the distance and angle based on the nature of the obstacles and convert this data into a visual representation of the data. The performance of the system is comparable to other machines in its class as it shows any problems found in its path and gives an estimate of the number of products. A very simple application of this system is in the field of search and avoidance systems for robots, or perhaps access to search space of such a size that it would not be cheap to use more rooms to provide adequate service. The range of the system depends on the range of the ultrasonic sensors used. In this system, HC-SR04 ultrasonic sensor with a range of 2 cm to 40cm is used.

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