ULTRASONIC RADAR SYSTEM

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Abstract : The application of radio detection and ranging (RADAR) in various sectors, such as military installations and commercial uses, relies on RADAR systems that use ultrasonic waves to detect physical parameters like distance, speed, position, range, direction, and size of both stationary and moving objects. RADAR technology has significantly advanced, particularly in navigation. This research explores existing navigation technologies and proposes an Arduino-based RADAR system. This system offers advantages over traditional RADAR systems by reducing power consumption and providing compatibility with a wide range of Arduino programmers and open-source code. The system includes an ultrasonic sensor mounted on a servo motor, which rotates at specific angles and speeds. Both the ultrasonic sensor and the servo motor are connected to the Arduino's digital input/output pins, enabling efficient and accurate detection.

Keywords : Arduino, Ultrasonic sensor, Servo motor, Radar.

I. INTRODUCTION :

Radar systems, essential for object detection and navigation, have evolved significantly, especially in military and commercial applications. Traditional radar systems, while effective, often come with high costs and complex setups. This project proposes an Arduino-based ultrasonic radar system, offering a cost-effective, energy-efficient, and accessible alternative. We know everything produces sound wave just by existence and effect flow of air around them with their natural frequency. These frequencies are beyond hearing range of humans. Wave of frequency range of 20000hz and thereabouts are called ultra-sonic wave and these waves can be detected by an ultrasonic sensor which helps us to get various knowledge. Utilizing ultrasonic sensors and servo motors, the system detects and measures object distance and position. This innovative approach leverages the Arduino platform's versatility and open-source resources, making it an excellent tool for educational purposes and practical applications in various fields.

II. OBJECTIVES :

The aim of this project is to design, develop, and implement an Ultrasonic Radar System for distance measurement and object detection. The primary objectives include :

Accurate Distance Measurement : Develop a system that accurately measures the distance between the radar device and

the surrounding objects using ultrasonic waves.

Object Detection and Tracking : Implement a mechanism to detect and track objects within the radar's range, providing real-time data on their movement.

Multi-Device Compatibility : Ensure compatibility with various devices or displays, allowing users to monitor the radar system remotely through a centralized interface. It is optional because it depends on user preference.

Customizable Alerts and Notifications : Implement a notification system to alert users in case of predefined events, such as the presence of an object within a specified proximity.

Energy Efficiency : Optimize the system's power consumption to extend its operational life and provide a sustainable long-term solution for distance measurement and object detection.

III. RATIONALE :

The rationale for developing an ultrasonic radar system using Arduino technology is rooted in the need for cost-effective, energy-efficient, and accessible solutions in the field of object detection and navigation. Traditional RADAR systems, while highly effective, often come with significant financial and operational costs, making them less feasible for smaller-scale applications or for use by hobbyists and educational institutions.

IV. BACKGROUND STUDIES :

The development of the ultrasonic radar system is grounded in a rich history of advancements in radar technology and its applications. Understanding the evolution and current state of radar systems is essential for contextualizing the need and innovation behind the proposed project.

History of Radar Technology : Radar (Radio Detection and Ranging) technology was first developed during the early 20th century, with significant advancements made during World War II for military applications. Early radar systems were designed to detect and locate enemy aircraft and ships, utilizing radio waves to determine the distance and direction of objects.

Principles of Radar Operation : Traditional radar systems operate by transmitting radio waves and analyzing the echoes that return after bouncing off objects. These systems can measure various parameters such as distance, speed, and direction.

Evolution of Ultrasonic Sensors : Ultrasonic sensors, which use sound waves rather than radio waves, have emerged as a cost-effective alternative for certain applications. These sensors are widely used in various fields, including robotics, automotive, and consumer electronics, due to their affordability, ease of integration, and ability to provide accurate distance measurements.

Existing Ultrasonic Radar Systems : Several projects and studies have explored the use of ultrasonic sensors for radar-like applications. These systems typically

involve rotating ultrasonic sensors to scan an area, creating a two-dimensional map of the surroundings. However, many existing implementations focus on basic functionality without optimizing for power consumption, flexibility, or ease of use.

Gaps and Opportunities : While traditional and ultrasonic radar systems have their respective strengths, there is a notable gap in affordable, energy-efficient systems that can be easily adapted for various uses. This gap presents an opportunity to develop an ultrasonic radar system that leverages Arduino technology to address these needs, providing a versatile tool for both practical applications and educational purposes.

V. MODELING AND ANALYSIS :

Hardware System Design : Hardware system consist of basically 3 components named as Arduino, servo-motor, and ultra-sonic sensor. Ultrasonic sensor is mounded upon a servo motor which helps it to move and provide it a turning mechanism. Both ultrasonic sensor and servo motor are controlled and powered by Arduino.

a) Arduino :

Figure 1 : Arduino UNO R3.

Arduino is an Italian open-source hardware and software company, project, and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices.

b) Servo-motor :

Figure 2 : Servo-motor(SG-90).

A servo motor is a rotary actuator that allows for precise control of angular position. It consists of a motor coupled to a sensor for position feedback. It also requires a servo drive to complete the system. The drive uses the feedback sensor to precisely control the rotary position of the motor.

c) Ultrasonic Sensor :

Figure 3 : Ultrasonic sensor(HC SR-04).

An ultrasonic sensor is an instrument that measures the distance to an object using ultrasonic sound waves. An ultrasonic sensor uses a transducer to send and receive ultrasonic pulses that relay back information about an object's proximity.

Hardware Circuit Design : Following figure shows hardware system design which was designed using fritzing environment. It shows the connection of

different electronics components. In the figure triggering pins of ultrasonic sensor is connected to 10th pin of Arduino, control line of servo motor is connected to 12th pin of Arduino and 11th pin of Arduino is connected to echo pin. VCC pins of servo motor and ultrasonic sensor is connected to 5V pin of Arduino while ground pin of Arduino is connected to ground pin of both servo motor and ultra-sonic sensor.

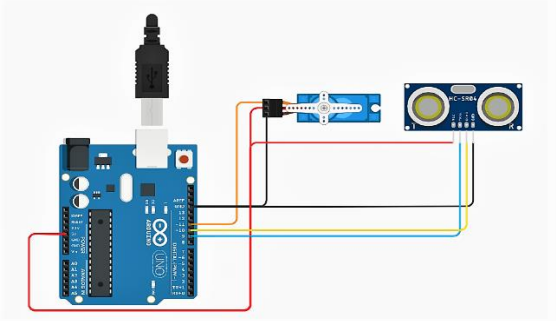

Figure 4 : Circuit Diagram.

Hardware System Implementation :

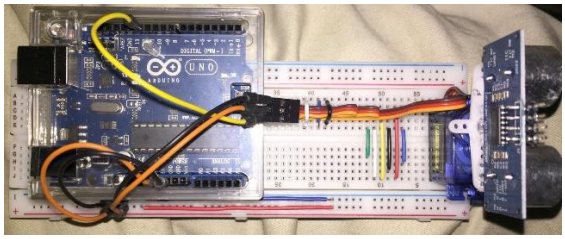

Figure 5 : Hardware Implementation.

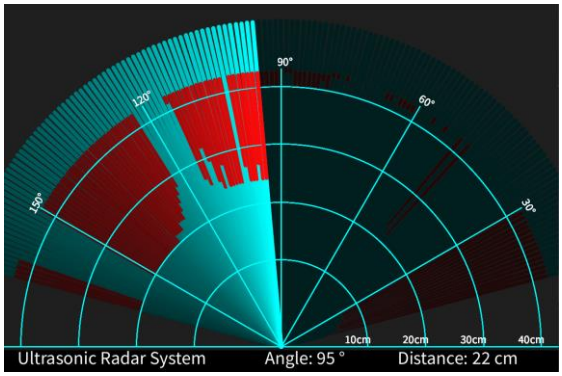

Figure 6 : Processing Interface.

VI. Conclusion :

The Arduino-based ultrasonic radar system not only meets the immediate objectives of cost reduction and power efficiency but also provides a versatile platform for future enhancements and applications. This project paves the way for more accessible and widespread use of radar technology, fostering innovation and learning in various fields.

VII. References :

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