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RADAR SYSTEM USING UNO

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Abstract

The application of radio detection and ranging in various locations, such as military installations and commercial uses, is facilitated by a Radar system that utilizes electromagnetic waves to detect different physical components, including distance, speed, position, range, direction, and size, which can be either stationary or in motion. The use of radar systems has significantly advanced, particularly in the field of navigation. In this research, we examine existing navigation technologies and propose an Arduino-based radar system. This system has advantages over other radar systems, as it reduces power consumption and connects to a wide range of Arduino programmers and open-source code. The system consists of a basic ultrasonic sensor mounted on a servo motor that rotates at a specific angle and speed. This ultrasonic sensor is connected to the digital input/output pins of the Arduino, and the servo motor is also connected to the digital input/output pins.

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

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1. Introduction

Everything produces sound waves simply by existing and affecting the flow of air around them at their natural frequency. These frequencies can be beyond the hearing range of humans. Waves with a frequency range of around 20,000 Hz are referred to as ultrasonic waves, and these can be detected by an ultrasonic sensor, which provides us with various information. An ultrasonic detector typically contains a transducer that converts sound energy into electrical energy and vice versa. They are used for measuring the position and orientation of objects, collision avoidance systems, surveillance systems, and more. Ultrasonic technology offers solutions to problems such as linear measurement issues, allowing users to obtain non-contact measurements, thus enabling easy measurement of distances and speeds of objects. The speed of sound waves depends on the square root of the ratio between the medium's density and stiffness. Additionally, the speed of sound can be affected by environmental conditions such as temperature. Essentially, an ultrasonic sensor emits ultrasonic waves that travel through the air and are reflected after hitting an object. By analyzing the properties of the reflected wave, we can gather information about the object's distance, position, speed, and more. A processing software and Arduino software are used in conjunction with the hardware system to detect various parameters of objects. One of the most common applications of ultrasonic sensors is range finding, also known as sonar, which is similar to radar. In this method,

ultrasonic sound is directed in a specific direction, and if there is an object in its path, it strikes that object and reflects back. By calculating the time taken for the wave to return, we can determine the object's distance. This method is similarly used by bats in real life.

Hardware Description:

The aim of this project is to calculate the distance, position, and speed of an object placed at a certain distance from the sensor[1]. The ultrasonic sensor emits ultrasonic waves in various directions by rotating with the help of a servo motor. These waves travel through the air and are reflected back after striking an object[2]. The sensor then detects these waves, analyzes their characteristics, and displays the output on a screen, showing parameters such as the distance and position of the object[3]. The Arduino IDE is used to write and upload code to the Arduino, which helps in sensing the position of the servo motor and transmitting this information to the serial port, along with the distance to the nearest object in its path. The sensor's output is displayed using processing software to provide the final output on the display screen. An ultrasonic sensor operates similarly to sonar; it measures the distance to an object by emitting sound waves[4]. These sound waves are sent at a specific frequency and direction, and the sensor listens for the returning sound waves. The time taken for the sound waves to return allows us to determine the distance to the object[5].

Fig. 1 Ultrasonic sensor

A servomotor is a rotary actuator that enables precise control of angular position, velocity, and acceleration[6]. It is composed of an appropriate motor paired with a sensor for position feedback. Additionally, it necessitates a relatively advanced controller, often a dedicated module specifically designed for use with servomotors[7]. Servomotors do not represent a distinct class of motor based on fundamental operating principles; instead, they utilize a servomechanism to achieve closed-loop control with a general open-loop motor. Servomotors are utilized in applications such as robotics, CNC machinery, and automated manufacturing[8].

Fig. 2 Servo motor

The Arduino is an open-source electronics platform that is based on user-friendly hardware and software[9]. The open-source Arduino software simplifies the process of writing code and uploading it to the board[10]. It is compatible with Windows, Mac OS X, and Linux. The environment is developed in Java and is based on Processing

and other open-source software[11]. This software can be utilized with any Arduino board. The Arduino software IDE includes a text editor for coding, a message area, a text console, and a toolbar with buttons for common functions[12]. It connects to Arduino and Genuino hardware to upload programs and communicate with them. Programs written using the Arduino software are referred to as sketches.

Fig. 3 Ardrino UNO

Breadboards are among the most essential components for learning how to construct circuits. In this tutorial, you will gain some knowledge about what breadboards are, the reason they are named breadboards, and how to utilize one[13]. By the end, you should have a fundamental understanding of how breadboards function and be capable of building a basic circuit on a breadboard.

Fig. 4 Bread board

Design Implementation of Radar System:

The figure 5 below illustrates the development life cycle of the Radar project, which includes various steps such as the design of different components, their testing, implementation, and the testing of the entire system. These steps can be categorized into the following stages: (a) Hardware System Design, (b) Hardware Circuit Design, (c) Hardware System Implementation, (d) Hardware Unit Testing, (e) GUI System Design, (f) GUI System Implementation, (g) GUI Unit Testing, (h) Entire System Integration,(i) Entire System Testing.

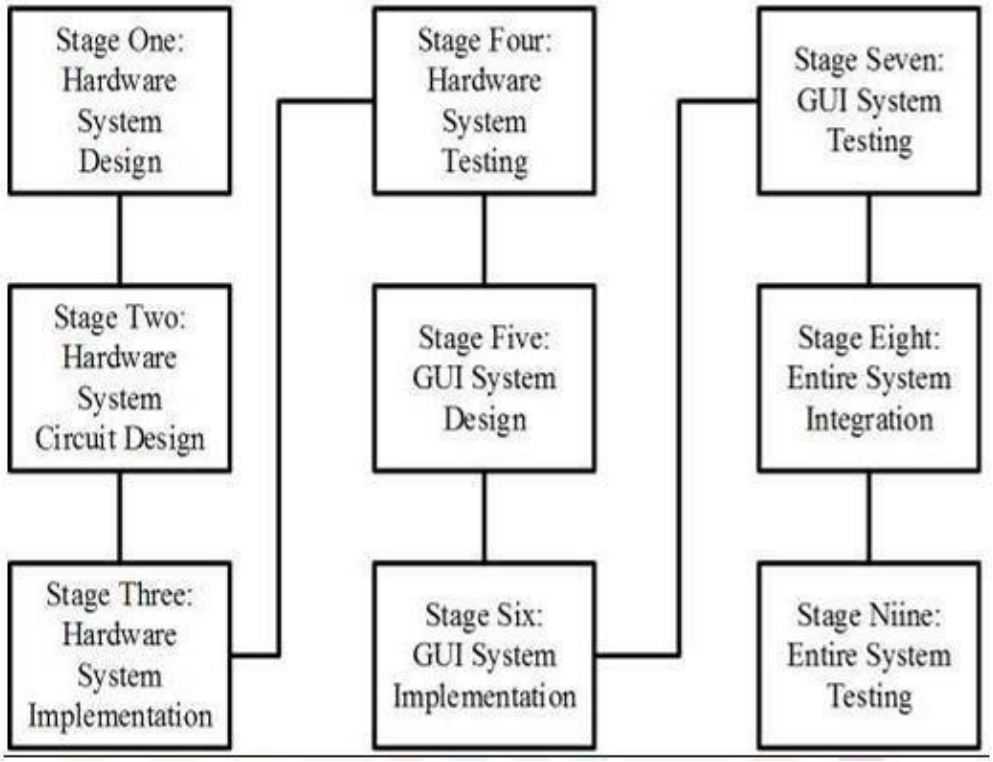

Fig. 5 Development life cycle of Radar System.

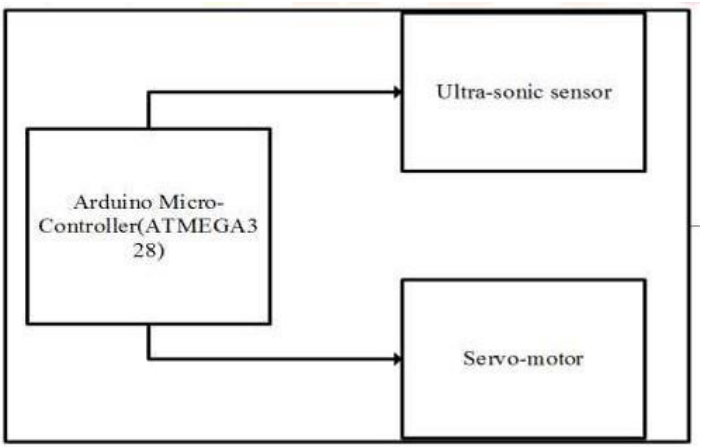

Fig. 6 Hardware System Design of Radar System

(a) **Hardware system design for Arduino:** The hardware system consists of three main components: an Arduino, a servo motor, and an ultrasonic sensor[14]. The ultrasonic sensor is mounted on a servo motor, which allows it to move and provides a turning mechanism. Both the ultrasonic sensor and the servo motor are controlled and powered by the Arduino. As shown in Figure 6 above, both the ultrasonic sensor and the servo motor are powered by the Arduino.

(b) **System circuit design:**

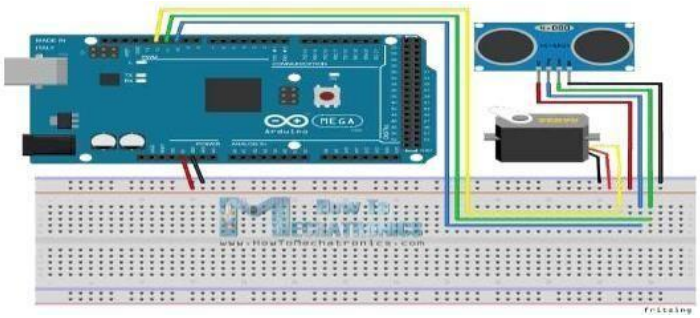

Fig. 7 Hardware Required

Working:

The main of this work is the calculation of the distance, speed and the position of any object which is placed in the radar range. Radar range is the maximum distance between the ultrasonic sensor and the object which can be calculated by the radar system. In this work the radar range is only 2cm to 40cm. With the help of servomotor; ultrasonic waves are transmitted in all the direction uniformly. This wave travels in the air and gets reflected back towards the radar ultrasonic sensor as soon as any object strikes. The reflected wave is sensed by the ultrasonic sensor and the characteristics of the reflected wave is to be analysed and after the analysis it is displayed in the screen which shows various paratemeters viz. distance and position of the object[15]. Arduino IDE is used for writing code and this code is uploaded in Arduino. Fig. 8 illustrates hardware system design which is created in Fritzing environment. Some of the most important pins are D8 pin of Arduino; which is connected to the ultrasonic sensor. Pin no D6 is connected to the servomotor and pin no D7 is connected to the echo pin.

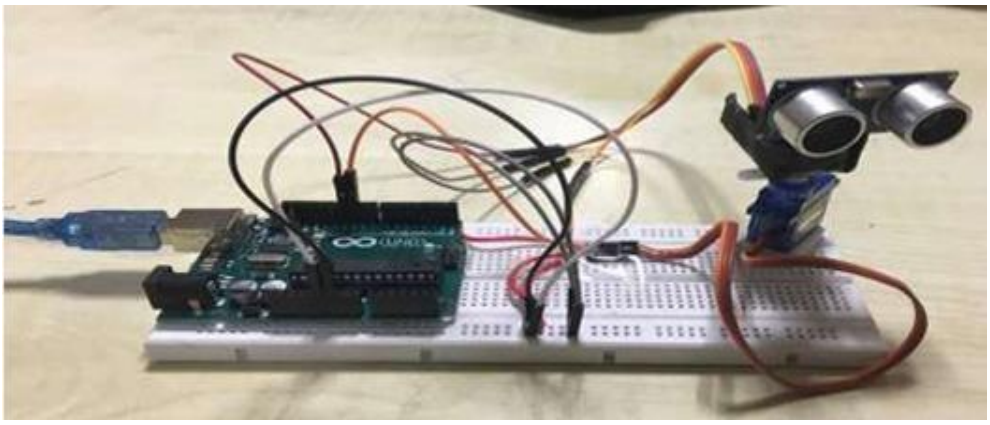

Fig. 8. Breadboard of the hardware system implementation

Results:

To know the working of implemented radar system; first of all ultrasonic wave is spread to the surrounding. For this purpose; servomotor is to be used. When the waves are stroke to the object then some of the waves are reflected back. The GUI system design and implementation involve the GUI. The programming language is written in the java script. Fig. 9 illustrates a line sweep from one direction to the other. A smudge creates in the graphical user interface if there is any obstacle found.

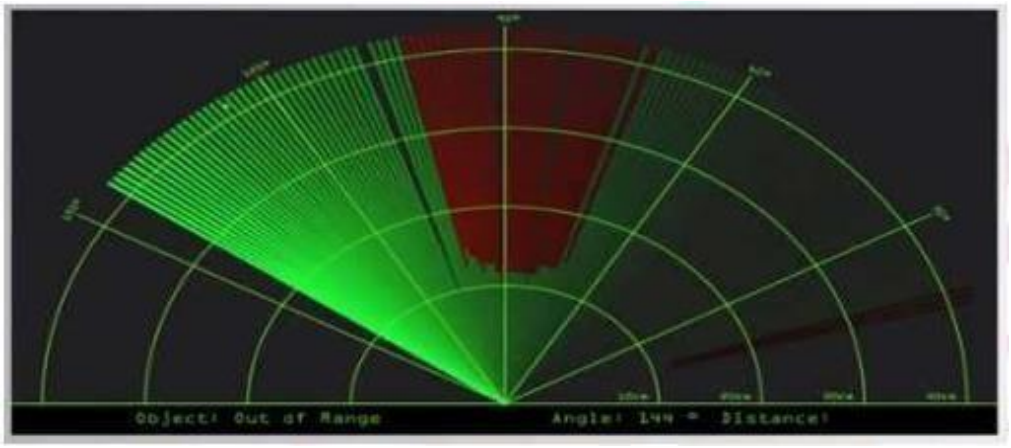

Fig. 9 GUI Implementation for the mapping interface.

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