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Pulse Scan: Arduino RADAR Mapping System

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Abstract

RADAR (radio detection and ranging) is the device which uses radio waves for the detection of obstacles in the path, with the use of Arduino and ultrasonic sensor we can make a small model of RADAR system. This research aims at creating a cost-effective radar-like system using Arduino microcontrollers and ultrasonic sensors. RADAR (Radio Detection and Ranging) is a technology that uses high-frequency signals or radio waves to track and detect objects by measuring the time it takes for signals to reflect from the surfaces. Traditional radar systems are widely used in navigation, aviation, meteorology, and defense but are often expensive and complex, making them limit their accessibility. This study focuses on developing an affordable alternative for object detection and tracking using Arduino's flexibility and the precision of ultrasonic sensors, which use sound waves instead of radio waves. The research covers hardware development, data acquisition, signal processing, and real-time visualization. This approach has potential applications in robotics, smart cities, industrial automation, and education, making radar-like technology more accessible and practical for various fields.

Keywords: Radio detection & ranging (RADAR), Arduino, Servo, Ultrasonic Sensor.

1. Introduction

The most use of radar technology is in Aviation & defense field. In aviation the work of RADAR is tracking aircraft, ensuring traffic management and Safety, it is also used as landing guidance for pilots. In defense it is used for surveillance on military targets. In recent years the small Radar systems or short-range radars are used for smart home application, automotive application, etc. [1].

Major components which are required for the Arduino radar system:

i). Arduino
ii). Ultrasonic sensor
iii). Servo motor

2. Component Review

a) Arduino: (Figure 1) it is a microcontroller. It acts as processing unit and controls the system. It is used for data processing.

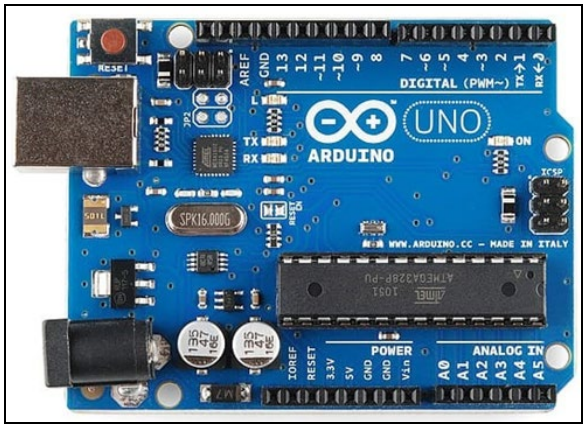

Fig 1: Arduino Board

b) Ultrasonic Sensor: (Figure 2) It is used to receive the high frequency sound waves. It has inbuilt transducer which acts as both transmitter and receiver.

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Fig 2: Ultrasonic Sensor (HC-SRC4)

c) Servo Motor: (Figure 3) It uses a closed loop feedback system with which it precisely controls the linear or rotational motion.

Fig 3: Servo Motor

3. RADAR Working Styling

Radio waves are used for the detection of obstacle or object. It also determines distance and speed (if the object is moving). Radio waves are sent through antenna. When the waves hit an object, it gets reflected. The antenna then receives the reflected wave. Working of RADAR is shown in Prepare Your Paper before Styling. (Figure 4 shows the working of RADAR) [2].

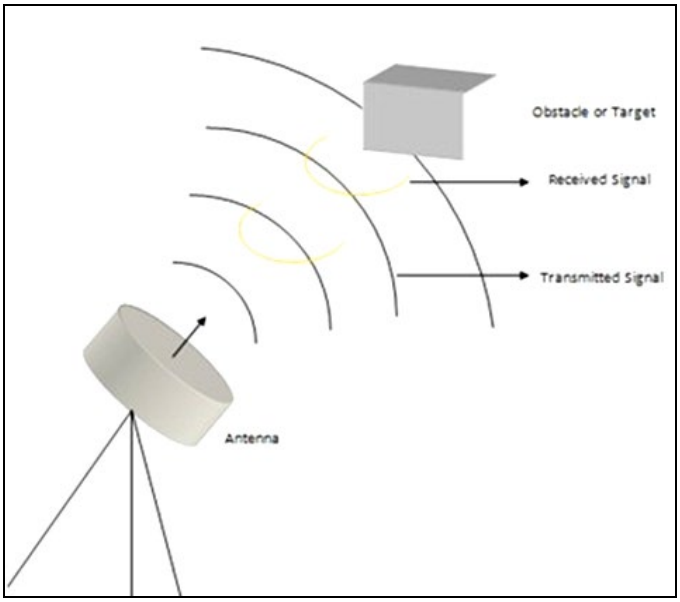

Fig 4: RADAR

a) Software Used

i). Arduino IDE: The Arduino IDE (Integrated Development Environment) is the software used to write, compile, and upload code to Arduino. It works on C and C++ and gives the built-in libraries for assign work.

ii). Processing 4: Processing 4 is a fourth version of processing software and programming language. It's easy to use, basically for beginners. How it works: It works very simply that you write your code to give instructions to the computer on what to do.

b) Working Principle

Arduino controls the servo motor which rotates the ultrasonic sensor. Servo motors control the movement of ultrasonic sensors so they can scan the wide area precisely [3]. (Figure 5 shows the Block Diagram of RADAR system.)

The sensor transmits high frequency sound waves, which reflects echoes back when encountered with object. With the help of the returned echo signal, it measures the distance of the object from the time taken by echo to return & the speed of sound in air. (Figure 6 shows the flow chart of the working of Arduino RADAR System.)

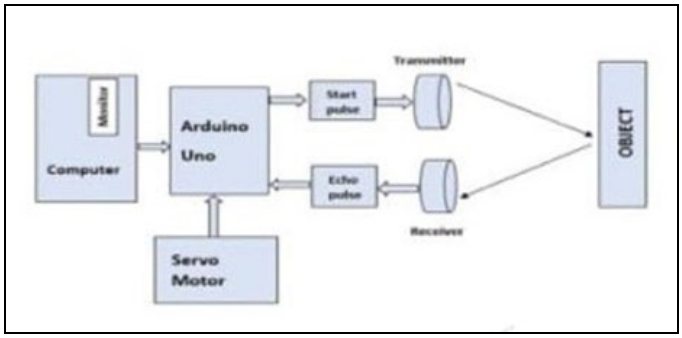

Fig 5: Block diagram of Arduino radar system

c) Visualization

When the obstacle or object is detected, with the help of RADAR technology, an echo pulse i.e. sound wave is returned to the antenna. Using Arduino and Processing 4 software the obstacle and its distance are shown on the monitor of the computer

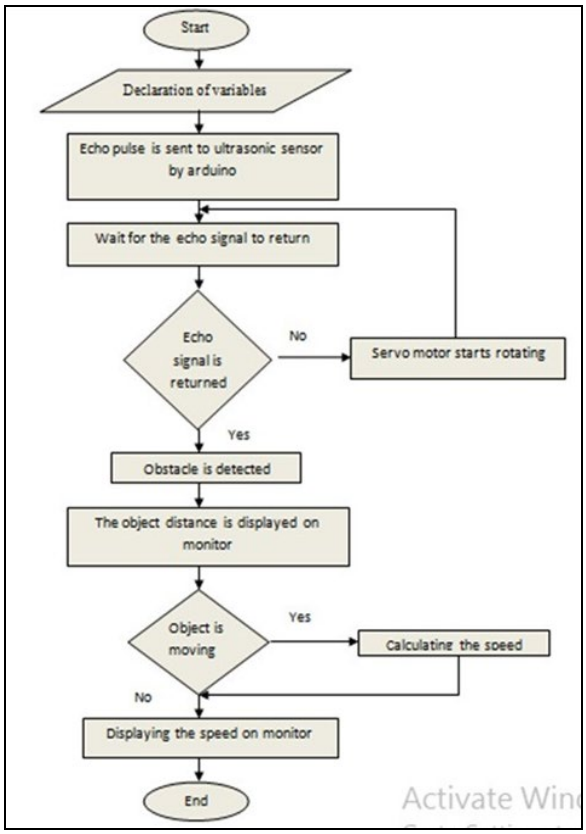

Fig 6: Flow Chart of Arduino RADAR System

Explanation of Code

a) Arduino Code:

include <Servo.h> control the motion of servo motor.
trig Pin = 10 and echo Pin = 11 for ultrasonic sensor.
Servo my Servo; to control the motion of motor.
Setup Function (setup ())
Sets OUTPUT as trig Pin and INPUT as echo Pin.
Join servo to pin 12.
Starts serial communication at 9600 baud rates.
Loop Function (loop ())
To repeat some action repeatedly like the servo from 15° to 165°, measuring distance at each step.
Prints the servo angle and distance to the Serial Monitor.
Moves the servo back from 165° to 15°, repeating distance measurements.

Distance Calculation (calculate Distance ())

Sends a trigger pulse from trig Pin to emit sound waves.
Measures the time taken for the echo to return using pulse in (echo Pin, HIGH).
Calculates distance by the formula:

Distance = duration × 0.034/2
Distance= 2 duration × 0.034

Where 0.034 cm/µs is the speed of sound in air.

b) Processing Code

Processing code is made to visualize real-time data from an Arduino-based radar system, basically using an ultrasonic sensor set up on a servo motor. The Arduino transmits data in the format `"angle distance."`, which the Processing reads through the `COM5` serial port at a baud rate of 9600. Once received, the data is analyzed into two integer values: `iAngle` and `iDistance`, presenting the distance measured and the angle of the servo to the closest object, respectively.
The program then uses this data to create a radar-like interface. It draws semi-circular arcs representing distance intervals (10cm to 40cm) and radial lines at angles ranging from 30° to 150° to create the appearance of a radar sweep. A green sweeping line moves according to the current angle, mimicking the rotation of a radar scanner. When it detects an object within the range of 40 cm, a red line appears at the corresponding distance and angle to indicate the object's location. If the distance is more than 40 cm, it displays “Out of Range” on the screen.
The background is drawn again with partial transparency to create a motion blur effect, giving a sense of movement and persistence like in real radar systems. The interface also includes textual feedback at the bottom of the screen, showing distance values and current angle, range status and distance markers. This makes it a functional and an spontaneous and visually engaging way to show sensor data. The program is a good epitome of how Processing can be used to create dynamic, real-time visualizations for physical computing projects.

Purpose:

The servo motor scans a large area, while the ultrasonic sensor calculates the distance of objects, making it helpful for radar systems, obstacle for papers with more than six authors: Add author names horizontally, moving to a third row if needed for more than 8 authors.

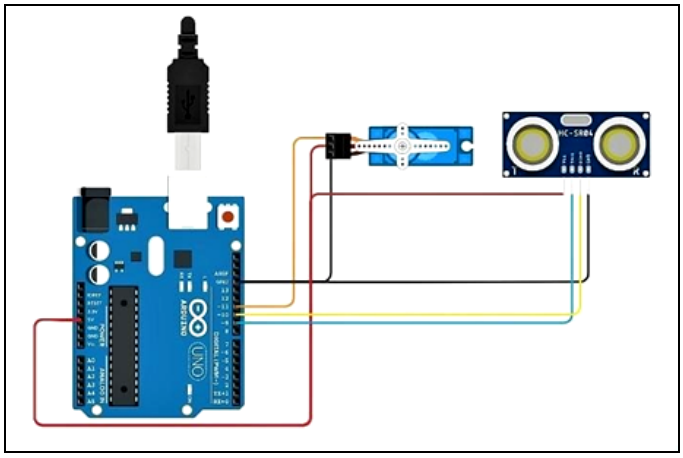

Fig 7: Schematic Diagram

c) Connections

The connections of Arduino RADAR system are shown in Figure 7. Connection
There are 4 Connections of ultrasonic sensors
i). Gnd to ground
ii). Vcc to 5v of Arduino
iii). Trig to D10 of Arduino
iv). Echo to D11 of Arduino

Whereas there are 3 connections for servo motor
i). Brown is connected to the ground of Arduino
ii). Red to 5v of Arduino
iii). Orange to PWM pin D9 of Arduino [4, 5].

d) Applications of Radar System

a) Military and Defence: Help the military to detect the enemy in the surveillance area.
b) Aviation: Helps in controlling air traffic and avoiding collision.
c) Meteorology: It is also use in weather monitoring for the information regarding storms and rainfall.

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