



ARDUINO-BASED RADAR OBJECT DETECTION SYSTEM FOR ACCIDENT PREVENTION

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ABSTRACT :

Radar is an object detection system that utilizes radio waves to determine the range, altitude, direction and speed of different objects. Used traditionally for detection of aircraft, ships, spacecraft, and guided missiles, it has been used for accident prevention in difficult geographical and climatic conditions. Particularly, mountainous areas and national highways afflicted with heavy fog and smog are being exposed to increased risk of accidents because of poor visibility. In our project, we describe how our Arduino radar system works and its suitability for reducing accidents. The unique feature of this system is that it consumes less power compared to the conventional radar systems, and it is open source, enabling it to be widely applicable to multiple uses.

KEYWORDS: Arduino Uno-R3, Servo Motor, Ultrasonic sensor, Wires, BreadBoard, Software etc..

1. Introduction

Even beyond human hearing, everything makes sound waves from its natural frequencies. Ultrasonic waves, which can be detected by ultrasonic sensors, are referred to as frequencies above 20,000 Hz. These sensors usually comprise a transducer that converts sound energy into electrical energy and vice versa. They are used for object position and orientation measurement, collision avoidance and surveillance systems.

Non contact measurements are provided by the ultrasonics technology that provide solution to the linear measurement problems. It is easier to measure the distance and the speed of the objects with this capability. The speed of sound in a medium is proportional to the square root of the density over stiffness of the medium, and can also be affected by environmental conditions, for instance temperature. The ultrasonic sensor emits some waves that travel through the air, reflect off objects, and come back. Analysis of the properties of these reflected waves will reveal object's distance, position, and speed. This is the same as how bats use sonar in real life. But smog has led to a 30 percent rise in road accidents in India with accidents rising from 500 a day on average to 650 on November 7 and 8, especially in Ghaziabad and Lucknow. IT experts from India-100 noted that this is an alarming trend. By using our ultrasonic radar system, such accidents can be prevented affordably and the accident prevention solution can be realized efficiently.

II. Literature

Radar (Radio Detection and Ranging) technology has been successfully used in automotive safety, air traffic control, etc. Radar systems are used in the context of road safety to detect objects around the vehicle to improve the ability to prevent collisions and in general to enhance situational awareness. Radar systems involve the emission of radio waves, and the analysis of the reflected signals for the position, distance, speed and movement of surrounding objects. Recent studies have addressed the use of radar technology in enhancing road safety by facility obstacles detection, driver monitoring and autonomous emergency braking (AEB) systems.

A flexible and affordable platform for implementing radar based detection systems is provided through the use of Arduino based systems. Computational power needed to process sensor data and control system components is provided by Arduino microcontrollers. It has been shown by many studies and projects that Arduino is feasible to be used in radar applications, mainly due to its open source nature and the possibility of integrating different radar modules with it.

III. Modelling & Methodology

Hardware Components:

Arduino Uno

Servo Motor

Ultrasonic Sensor(HC-SR04)

Breadboard

Jumper Wires

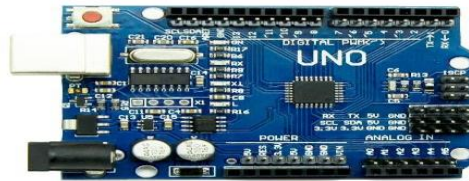
USB Cable

Software Components:

ArduinoIDE

Processing Software

1.Arduino Uno-It is a Microcontroller board based on ATmega328. The set has 14 digital output/input pins out of which 6 can be used as PWM outputs, 6 analog inputs, a ceramic resonator of 16MHz, USB, power jack, ICSP header, and a reset button.



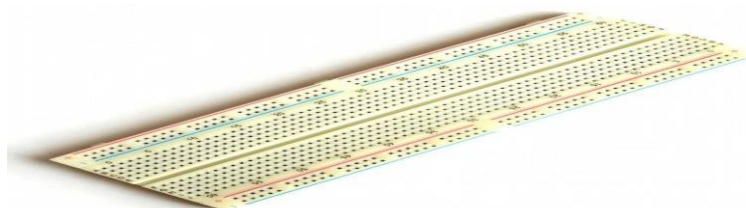
2 Ultrasonic Sensor- This HC-SR04 ultrasonic sensor is an economical sensor which can provides 2 cm to 150 cm of non-contact measurement feature with ranging accuracy up to 3mm. Each sensor consists of ultrasonic transmitter, a receiver and a control circuit. There are 4 pins of main concern: VCC (Power), Trig (Trigger), Echo (Receive), and GND (Ground).



3.Servo Motor - It is a motor which rotates with great precision. Usually, this motor include a control circuit that provides you with feedback of the current position of the motor shaft, now this feedback enables the servo motors to rotate with precision. You can use a servo motor to rotate an object at some specific distance or angles.



4.Breadboard - It is a solder less device that is used for temporary prototype with test circuit designs and electronics. In electronic circuits most electronic components can be connected with each other by inserting their terminals into the holes and then making connections through wires.



5.Jumpers - These wires are wires that consist of connector pins at each end, enabling them to be used to connect two points to each other without soldering.



6.Arduino IDE – It consist of a text editor for code writing , a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino hardware components to upload programs and communicate with them.



Processing Software - It is a flexible software sketchbook and language for learning coding within the context of the visual arts. There are several thousand students, artists, designers, researchers, and hobbyists who make use of Processing for learning and prototyping.

Distance Calculation:

Distance L is calculated by the formula as:

$$\text{Distance } L = \frac{1}{2} \times T \times C$$

L is the Distance.

T is the time taken between emission and reception.

C is the speed.

Features:

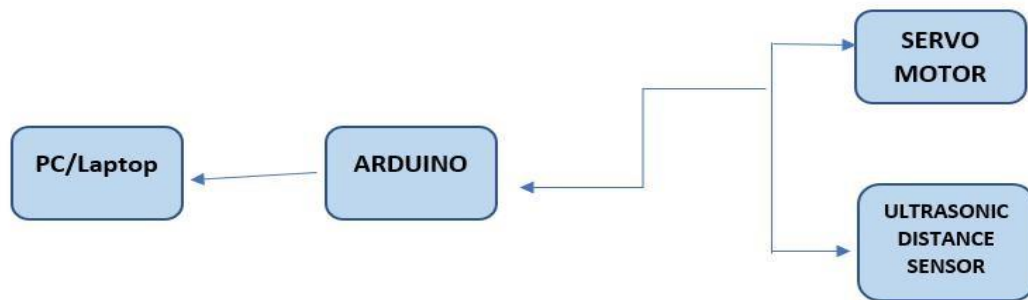
Clear object detection.

Functioning even in presence of dirt and fog.

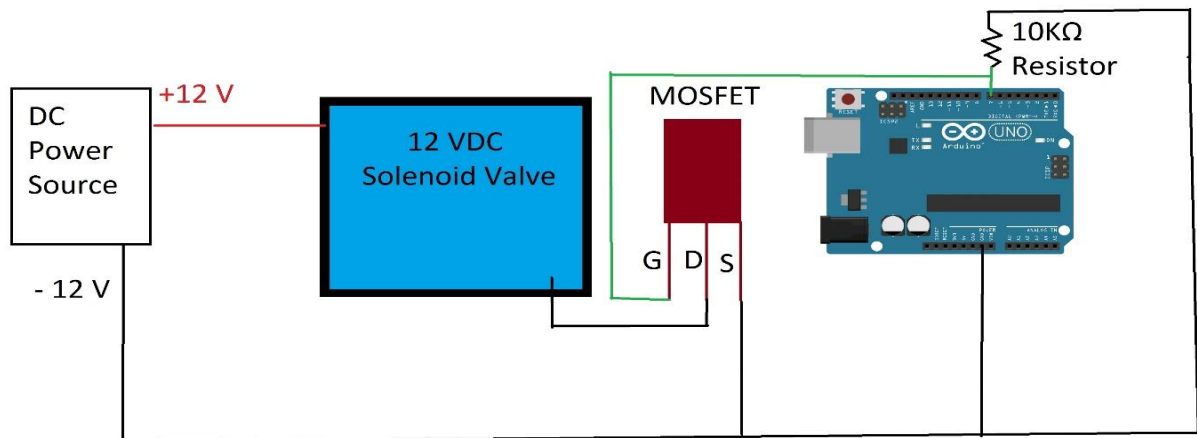
Stable for intricate-shaped objects.

III System Design and Implementation

Block diagram:



Circuit Diagram:



Working of Hardware:

The objective of this project is to find the distance and position of an object placed at a certain distance from the ultrasonic sensor. Ultrasonic sensor fires the ultrasonic wave in different directions by rotating through servo motor.

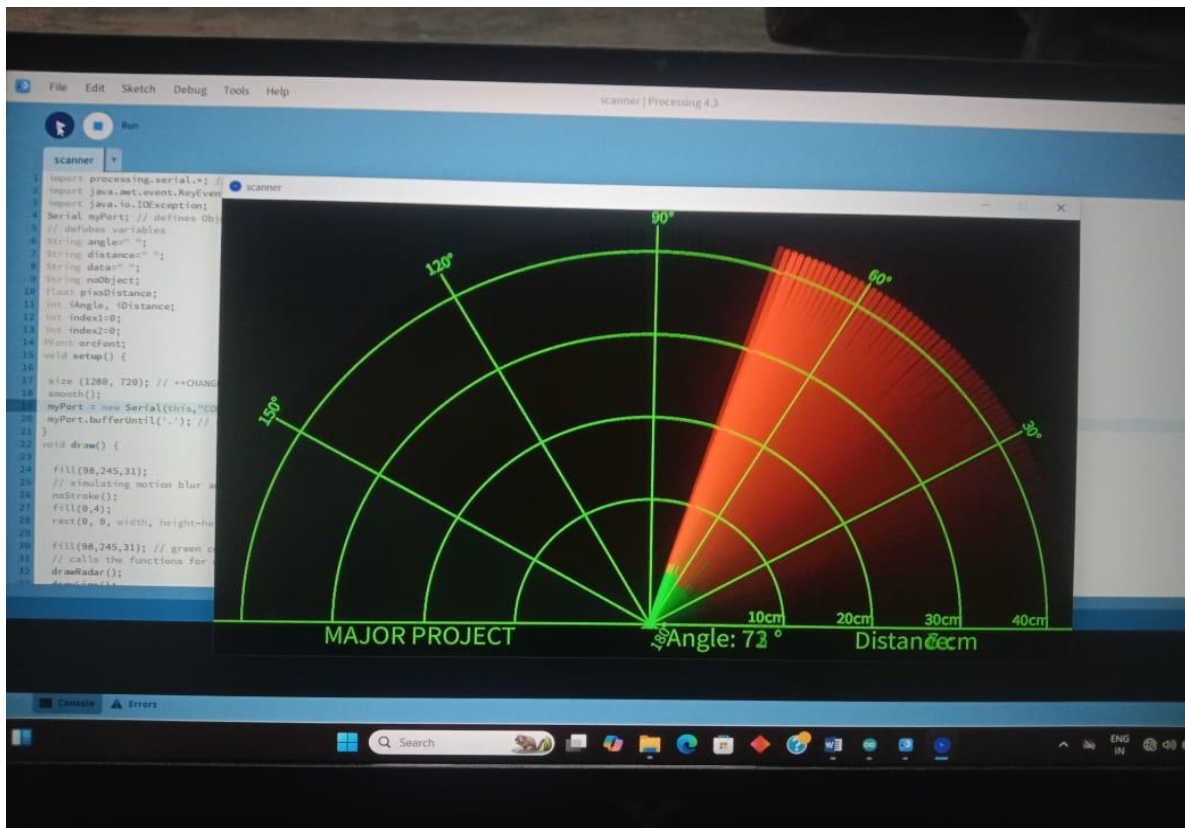
This wave propagates in air and is reflected back as it hits some object. This wave is then sensed by the ultrasonic sensor and its behaviour is examined and the output is displayed on the screen, deciding parameters such as distance and object position.

The objective of this project is to determine the distance position and velocity of the object that is kept at certain distance from the sensor. Ultrasonic sensor broadcasts ultrasonic wave in various directions by rotating with the assistance of servo motor. The wave propagates in air and reflects after it strikes some obstacle. This wave is detected once by the sensor and its feature is processed and output is provided in screen displaying parameters like distance and object position.

Arduino IDE is utilized to program and upload programming in Arduino and helps us sense position of servo motor and post it to the serial port along with the distance of nearest object in its path. Sensor output is shown with the help of processing software to give final output. Print to display screen.

Hardware of the project:

1. Object is not detected in the scanner.



2. Object is detected in the scanner.

Processing Software (Processing 3) is used to give the output of the sensor in the display screen of your PC/Laptop as the final output.

ADVANTAGES

1. Obtainable radar value is extremely low.
2. Working and maintenance value is low.
3. Active distance resolving value is high.
4. Radar jamming is a problem.
5. It can be employed in any location.
6. Radio detection and ranging are used by NASA to map the world and other planets.
7. Activity is made updated towards the end.

Limitations:

1. This radar is completely based on sound sensing, hence because of lack of air it cannot operate in vacuum since it is a propagation medium.
2. Detection range will vary on the ultrasonic sensor employed.
3. Apparently soft objects made of fabric tend to absorb more sound waves thus becoming hard to detect.

Conclusion:

Arduino-Based Radar Object Detection System for Accident Prevention forcefully establishes itself as a cost-efficient and effective approach towards detection of objects in the vicinity of a car by utilizing ultrasonic sensing technology. Through the inclusion of operations of an ultrasonic sensor, servo motor, and Arduino UNO, and provision of information through the use of Processing software, the system can scan its surroundings in radar-like manner. This real-time sensing informs the driver about the proximity of obstacles, and it can decrease accident probabilities, particularly during conditions of poor visibility like fog, night time, or dense parking areas. It is a simple, robust, and scalable system, ideal as an operating prototype to be further enhanced.

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