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IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 7 Issue 8, August 2020
ISSN (Online) 2348 – 7968 | Impact Factor (2020) – 6.72
www.ijiset.com

A Short-Range Radar System Using Arduino

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Abstract

RADAR is a detection system that uses radio waves to determine the characteristics of the detected objects such as: range, height, direction, or the speed of objects. In this paper, we designed a radar system that uses an ultrasonic sensor to detect objects. In this paper, the ultrasonic is used to measure the distance between the radar and any object-based non-contact technology. Whereas, the movement of the sensor is controlled by using a small servo motor. This radar-controlled using the Arduino Uno board as a microcontroller. The signal received from the sensor would be processed using "Processing Development Environment Software," then the result would be shown on a PC screen.

Keywords: *Radar, Ultrasonic Sensor, Arduino Uno, Servo motor.*

1. Introduction

RADAR is a method of object detection using radio waves to determine objects' size, height, direction or speed. Radar systems are available in various sizes with various performance requirements. Some radar systems are used in airport air traffic control, others are used in long distance surveillance systems and early warning systems. The heart of a missile guide system is a radar system. Small compact, individually maintainable radar systems and systems occupying many spacious rooms are available. [1]

Several nations secretly developed the radar before and during the Second World War. United States Navy coined the term RADAR itself as an acronym of radio detection and a range of other developments in 1940. New uses of the radar include a wide range of air traffic control systems including, radar, astronomy, air defense systems, antimissile systems, marine maritime radars for the identification and repositioning of sites and other vessels, aircraft collision anti-collision systems, sea surveillance systems, outer space monitoring, and rendezvous systems. Digital signal processing is linked to high-tech radar systems. [1]

2. System Overview

The Block diagram of Short Range Radar System Using Arduino is as shown in (Figure 1). In this work, the distance of the object is measured through an ultrasonic distance sensor, and the sensor output is connected to the signal conditioning unit. After that, it is processed through the Arduino microcontroller. The measured results are displayed on the personal computer. The sensor is attached to the servo motor to find the polar distance around the sensor up to 180 rotations.

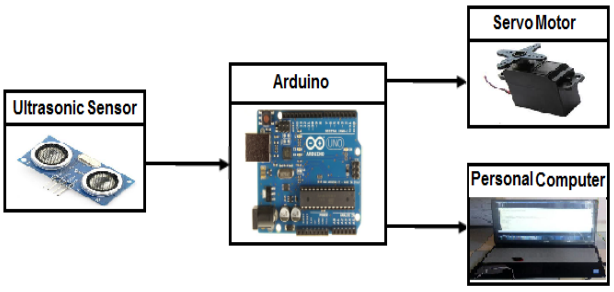


Fig. 1 Block diagram of the system.

3. Components Required

3.1 Arduino Board UNO Model

Arduino is an open-source computer hardware, open-source software and microcontroller-based device building kit and interactive objects that can sense and control physical devices. arduino designs and manufactures software, software and software.

The project is focused on the design of the microcontrollers. The board contains a combination of digital and analog input / output (I / O) pins, which can connect to specific expansion boards (termed shields). The plates have serial communication interfaces for loading programs from personal computers, including Universal Serial Bus (USB) in the UNO model [3].

The Arduino project provides the built-in development environment (IDE) for the programming of microcontrolling systems to allow code writing and uploading to the board. It runs on Mac OS X, Linux and Windows. The code is written in Java, which is based on open source software and processing. You can use this program on any board of the Arduino (Figure 3).

Fig. 2 Arduino UNO.

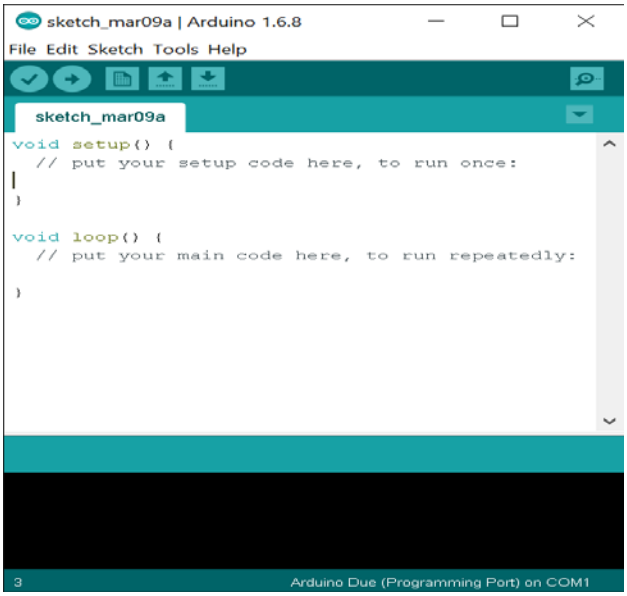


Fig. 3 IDE Software.

3.2 Processing

All processing is an open-source computer programming language and integrated development environment (IDE) built for the electronic arts, new media art, and visual design communities to teach the fundamentals of computer programming in a visual context (Figure 4). The Specifications of programming:

- Free to download and open source
- Interactive programs with 2D, 3D or PDF output
- OpenGL integration for accelerated 2D and 3D
- For GNU/Linux, Mac OS X, and Windows
- Over 100 libraries extend the core software
- Well documented, with many books available

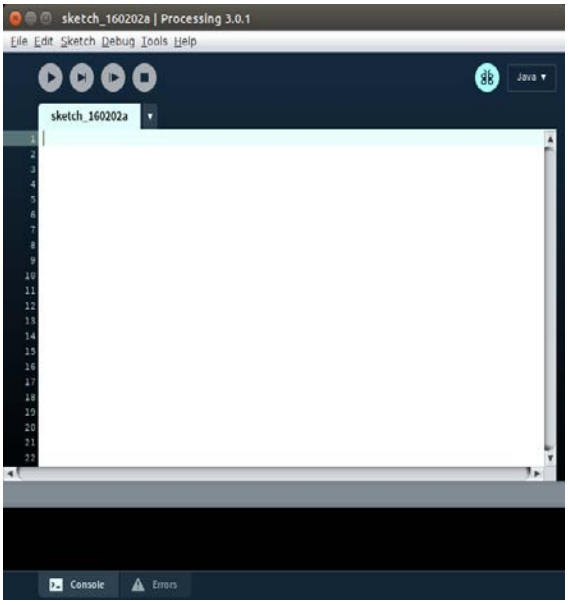


Fig. 4 Software and processing.

3.3 Ultrasonic sensors HC- SR04

The ultrasonic sensor emits ultrasound at 40 000 hz, which passes through the air, while it bounces back into the module if there is an object or obstacle in its way. The distance can be determined based on the travel time and the speed of the sound.

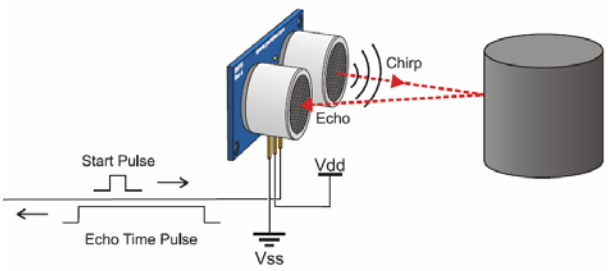


Fig. 5 Ultrasonic Sensor

The sound speed is around 341 meters per second (1100 feet) in air. This information and the time difference between transmitting and receiving the sound pulse are used by the Ultrasonic Sensor to calculate the distance from an object. The mathematical equation used is the following:

$$\text{Distance} = \text{Time} \times \text{Speed of Sound} / 2 \quad (1)$$

Time = the time between when an ultrasonic wave is transmitted and when it is received.
You divide this number by 2 because the sound wave has to travel to the object and back.

3.4 Servo Motor

Tiny and lightweight with high output power. The servo will rotate about 180 degrees (90 in each direction) and operate just as small as the regular types (Figure 6). To monitor these services, you can use any servo code, hardware or library[4]. The Specifications of servo motor:

- Weight: 9 g
- Dimension: 22.2 x 11.8 x 31 mm approx.
- Stall torque: 1.8 kg f cm
- Operating speed: 0.1 s/60 degree
- Operating voltage: 4.8 V (~5V)
- Temperature range: 0 ºC – 55 ºC

Fig. 6 Servo motor.

The interfacing between the PC and the Arduino is done by RS232 USB. The Arduino receives the data from the ultrasonic sensor and process it. In the Arduino software, equation (1) is used to calculate the object distance. Also, the position angle of radar is calculated and controlled from the Arduino program. The Arduino sends these data, which are the angle position and the object distance to processing software to show them on the radar screen. The figure 7 shows the design of hardware that was designed with a scraper environment. The connection of different electronic components is displayed.

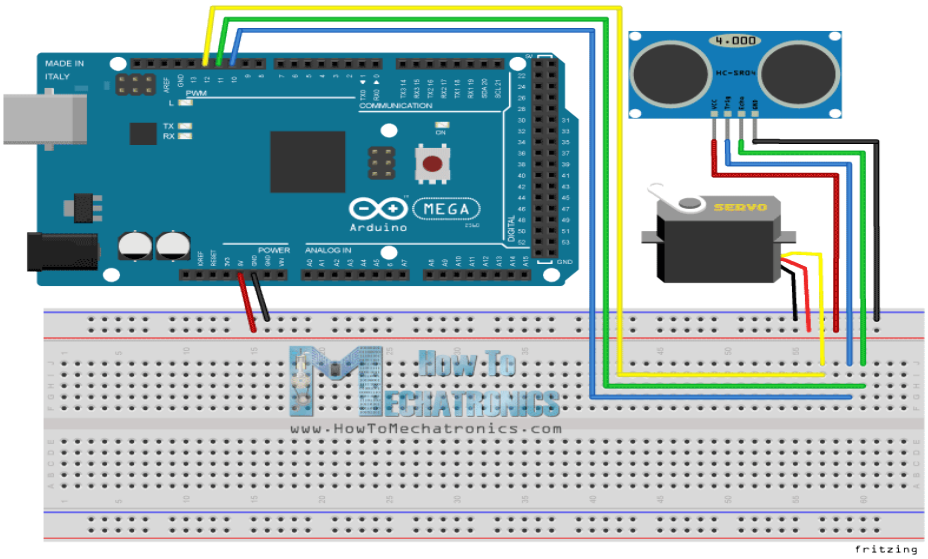
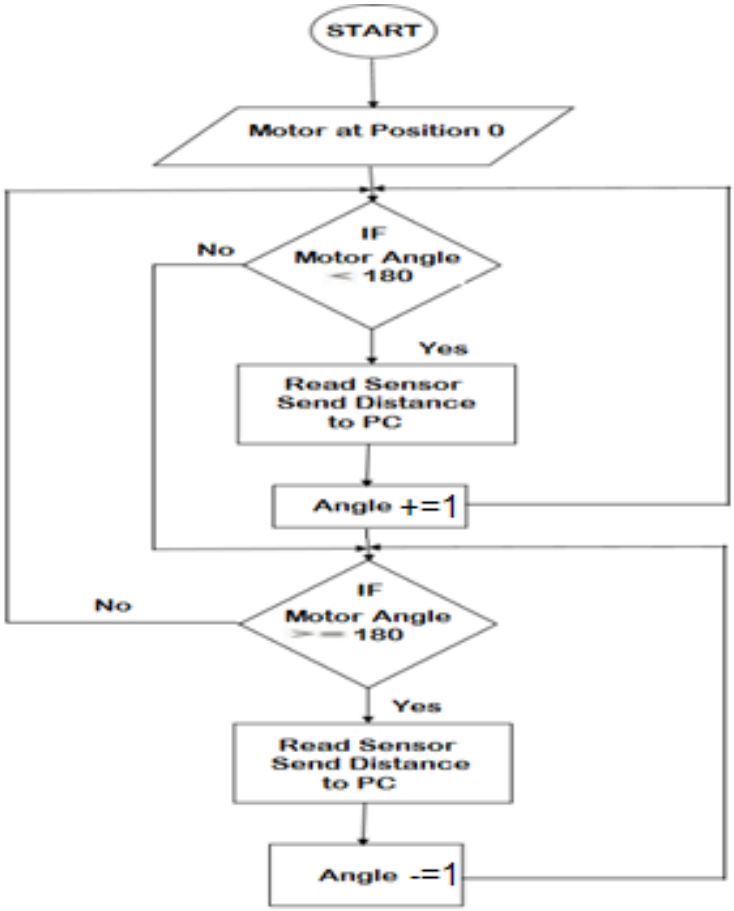


Fig. 7 Hardware system design.

4. Flowchart

The flowchart shows the overall operation of the system following software to control the servo motor.



5. Results

The hardware model of the project is shown in Figure 8.

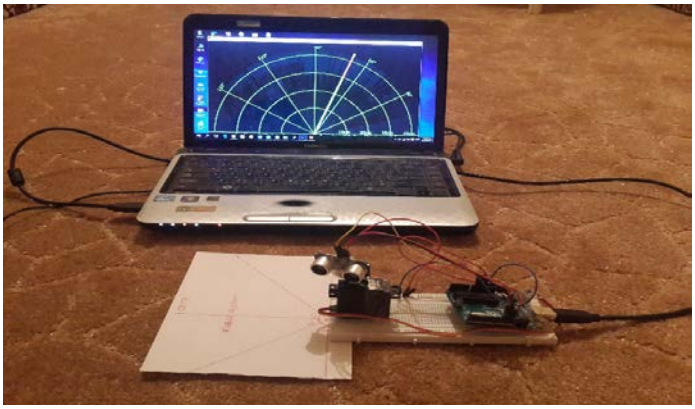


Fig. 8 Hardware model of the project

The radar workspace is shown in Figure 9.

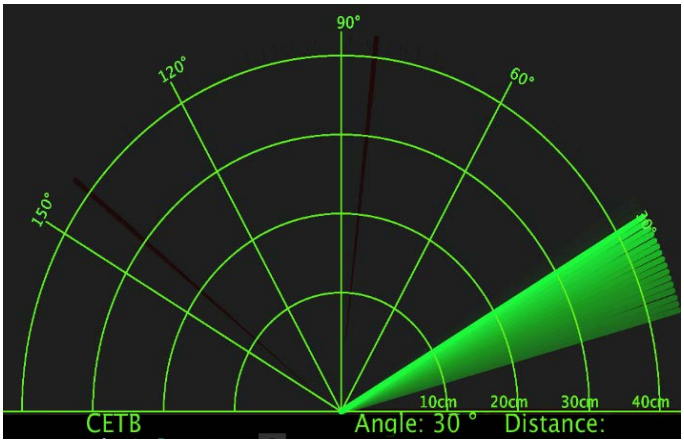


Fig. 9 Radar workspace

Figure 10 illustrates the radar when detects an object

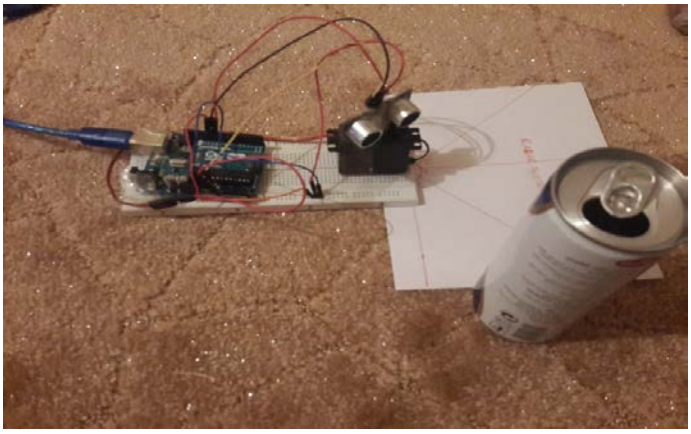


Fig. 10 Radar with object

Figure 11 shows object radar information on radar workspace where the distance between object and radar is 11cm, and angle is 160.

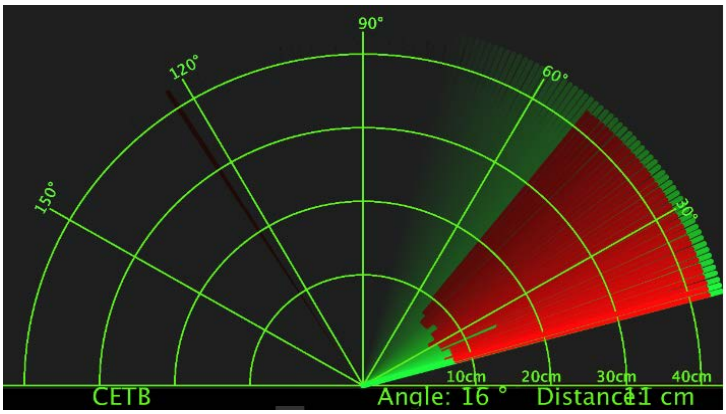


Fig. 11 Radar information

6. Applications

The radar system is used mostly for mapping and has several uses for protection purposes.

- Application in Air Force:

This is used for the identification of items that come in by aeroplans or aircraft devices that have a radar device in it. It is often used for the height measurement calculation.

- Application in Marine:

It is also used in ships or in marine applications. The distance of other boats or ships is measured on big ships and can be minimized by not colliding with the aid of this sea accident. It can also be used at ports to see the distance from other vessels and track or monitor the movements of the vessels.

- Application In Meteorology:

Wind tracking or monitoring is also done with radar systems. It has become a major climate monitoring equipment. For starters, storms are used to detect tornados.

7. Conclusion

The aim objective of this paper was to design and implement a simple radar system. The mentioned system can detect the objective and measure the target distance. Short-range radar system a low cost, a simple device for distance measurement. The software results have been verified by using rubber and paper with a drawn angle. Hence, the device calculates the distance with suitable accuracy and resolution. The data converted into visual information. The appliance of the device is numerous.

References

[1] Anuj Dutt, Arduino Based RADAR System. United States: GRIN Verlag, Jun 25, 2014.
[2] Ultrasonic RADAR/Electronic Design Lab (EE-318) Submitted by: Praveen Tamhankar (06d07007), Piyush Mittal (06d07035), Ashutosh Singh (06d07034) Guide: Prof. Jayanta Mukhergee.
[3] http://www.arduino.cc
[4] Servo motor datasheet.
[5] http://howtomechatronics.com/projects/arduino-radar-project
[6] M. Ishihara, M. Shiina, S. Suzuki, "Evaluation of Method of Measuring Distance Between Object and Walls Using Ultrasonic Sensors", Journal of Asian Electric Vehicles, Volume 7, Number 1, June 2009.
[7] Y. B. Gandole, "Simulation and data processing in ultrasonic measurements", Anadolu University Journal of Science and Technology, Vol.:12, No: 2, pp. 119-127, 2011
[8] G. Benet, J. Albaladejo, A. Rodas, P.J. Gil, An intelligent ultrasonic sensor for ranging in an industrial distributed control system, in: Proceedings of the IFAC Symposium on Intelligent Components and Instruments for Control Applications, Malaga, Spain, May 1992, pp. 299–303.
[9] G. Benet , F. Blanes, J.E. Simó, P. Pérez, Using infrared sensors for distance measurement in mobile robots, Else viewer , Robotics and Autonomous Systems 1006 (2002) 1–12.