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Implementation of an Radar System using Arduino

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Abstract

Radar was developed as a method of detecting enemy aircraft in World War 2. Along with the developments in technology, these days it is used in a wide range of sectors. Since the last few decades, there have been significant advancements in the use of radar technology. In this project, we have designed an Arduino radar using Ultrasonic Sensor for detection of Targets and measuring Range. An Arduino microcontroller makes electronics more discipline. This Arduino radar project aims to achieve a radar system prototype based on an Arduino board that detects stationary and moving objects. The radar system has different performance specifications, and it is also available in a variety of sizes. Distance measurements and Target detection can be visualized by Processing application. Processing application is visual arts-based software for learning to code.

Keywords: RADAR, Ultrasonic Sensor, Servo motor, Processing IDE.

I.Introduction:

Radar is an object detection system that uses electromagnetic waves to identify range, altitude, direction or speed of both moving and fixed objects such as aircraft, ships, vehicles, weather formations and terrain. When we use ultrasonic waves instead of electromagnetic waves, we call it ultrasonic radar . The main components in any ultrasonic radar are the ultrasonic Sensors. Ultrasonic sensors work on a principle similar to radar or sonar which evaluates attributes of a target by interpreting the echoes from radio or sound waves respectively. Radar's information will appear in different ways. Basic and old radar station used sound alarm or LED, modern radar uses LCD display to show detailed information of the targeted object. We use Computer screen to show the information (distance and angle).

II. Problem Statement:

When the airplanes were invented there is no instrument that could detect their location and time. So there is a need of a system that could detect the aircrafts in air. To overcome this problem the scientists invented the "Radar System" and our whole defence system,airtraffic and airport system is based on it.

The complexity of the existing arduino radar system in the market nowadays is too high in terms of design and structure. But it has poor range of distance detection,displaying only distance without angle,lack of showing the exact results. Hence our proposed system will reduce the complexity and will be available in a low cost.

II.a.OVERVIEW OF EMBEDDED SYSTEM

Every embedded system consists of custom-built hardware built around a Central Processing Unit (CPU). This hardware also contains memory chips onto which the software

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is loaded. The software residing on the memory chip is also called as 'firmware'.

The same architecture is applicable to any computer including a desktop computer. However, there are significant differences. It is not compulsory to have an operating system in every embedded system. For small appliances such as remote control units, air conditioners, toys etc., there is no need for an operating system and you can write only the software specific to that application.

For applications involving complex processing, it is advisable to have an operating system. In such a case, you need to integrate the applications software with the operating system and then transfer the entire software on to the memory chip. Once the software is transferred to the memory chip, the software will continue to run for a long time you don't need to reload new software.

Now, let us see the details of the various building blocks of the hardware of an embedded system. As shown in Fig. the building blocks are: 1.Central Processing Unit (CPU)
2.Memory (Read-only Memory and Random Access Memory)
3.Input Devices
4.Output Devices
5. Communication Interfaces
6. Application-specific Circuitry

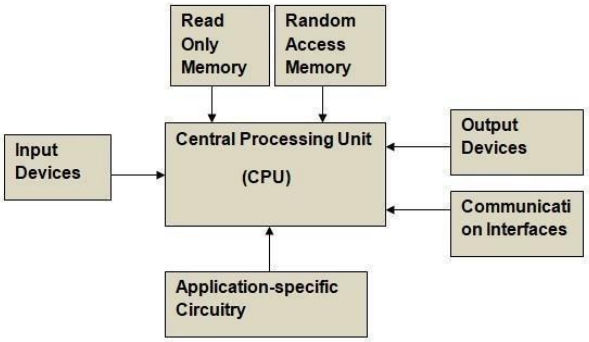

Fig: 1 Building blocks of the hardware of an embedded system

III. System Requirements

In this chapter we are going to explain about the system design construction through hardware and development of software. In addition the chapter elaborates the hardware and software stage by stage. All the operations of software and hardware are also included in this chapter.

III.a. Hardware Requirements:

- Arduino UNO
- HC-SR04 Ultrasonic Sensor
- TowerPro SG90 Servo Motor
- Bracket for Ultrasonic Sensor (optional)
- Jumper Cables
- 9V Power Supply
- USB Cable (for Arduino)

III.b. Software Requirements

- Arduino IDE
- Processing Application

As the system requires the use of microcontroller, the design consists of two parts, hardware and software. Hardware is constructed an integrated module by module, hardware to software for easy troubleshooting and testing.

Here, it can be seen how the work flow in this radar system. The sensor is going to sense the obstacle and determine the angle of incident and its distance from the radar. The servo motor is constantly rotating to and fro, hence making the sensor move. The data obtained is encoded and fed to the processing IDE which represents it on the screen. The results are displayed further in this next chapter. All these operation are done by Arduino

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microcontroller from the rotation of the servo, data collection from the sensor, feeding the data transferring it to the display. The system block diagram shown in the below figure:

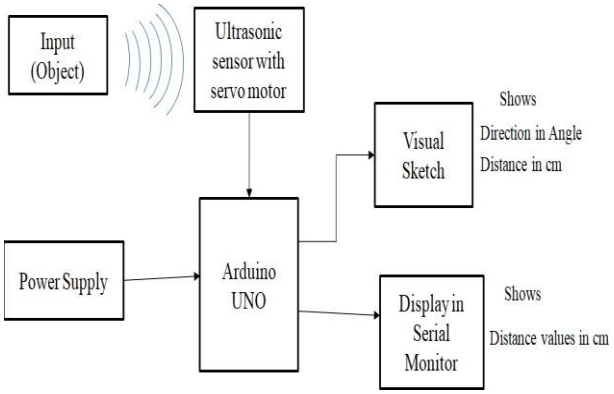

Fig: 2 System Block Diagram

III.c.System Implementation

● Lets start the connections

● Connections with arduino uno

● Connect vcc of servomotor and vcc of ultrasonic sensor to 5v of arduino .

● Connect the gnd of ultrasonic sensor and servo to ground of the arduino .

● Connect trig and echo pin of ultrasonic sensor to 8 and 7 of arduino. ● Connect signal pin of servo to pin 9 of arduino.

● Connection with arduino nano for nano users
● Connect vcc of servomotor and vcc of ultrasonic sensor to 5v of arduino .

● Connect the gnd of ultrasonic sensor and servo to ground of the arduino

● Connect trig and echo pin of ultrasonic sensor to D10 and D11 of arduino nano.

● Connect signal pin of servo to pin D12 of arduino nano.

● In the code just change pins to D10, D11, D12.

Arduino Uno	Ultrasonic Sensor	Servo Motor
Vcc	Vcc	Vcc
Gnd	Gnd	Gnd
D10	Trig	-
D11	Echo	-
D12	-	Signal

Table: Connections

IV. Working :

First of all, the hardware of the units of the system were tested and it was ensured that in a good working condition or not. Then each and every unit were interfaced implemented individually with the microcontroller board and drove the with the software according to the necessity application. The testing of the application was not done at once after it was completed. Rather each unit of the application was not done at once after it was completed. The second unit was not tested until the first unit gave the expected result and until it was not working according to the necessity of the application. After all the units were working

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correctly, the units were kept together and then the whole system was developed and tested.

The basic objective of our design is to ascertain the distance position and speed of the obstacle set at some distance from the sensor. Ultrasonic sensor sends the ultrasonic wave in various ways by rotating with help of servo motors. This wave goes in air and gets reflected back subsequent to striking some object. This wave is again detected by the sensor and its qualities is analyzed and output is shown in screen indicating parameters, for example, distance and position of object. Arduino IDE is utilized to compose code and transfer coding in Arduino and causes us to detect position or angle of servo motor and it is communicated through the serial port alongside the covered distance of the nearest object in its way.

Output of all of this working is shown in the software called processing, it will display the input/output and the range of the object . Implementations of the sensors are done in such a way that ultra-sonic sensor is attached on top of the servo motor because it have to detect the object and its distance. Arduino (micro-controller) will control the ultra-sonic sensor and servo motor and also powered will be given to both of them through micro controller .

A Graphical representation of the data from the Ultrasonic Sensor is represented in a Radar type display. If the Ultrasonic Sensor detects any object within its range, the same will be displayed graphically on the screen.

V. Result:

The aim of this project is to design and implement the Radar system using Arduino. Here we place an object in front of the ultrasonic sensor. When the servo motor rotates, the objects enters in the range of the ultrasonic sensor. The appearance of an object appears on the screen. We have shown the presence of an object with the red mark. If there is no object in the processing application range of the ultrasonic sensor, it shows green marks.

The below figure represents the hardware kit of implementation of Radar System using Arduino.It consists of Ultrasonic sensor, servo motor, Arduino uno, mounting bracket, 9V power supply, USB cable.

Fig: 3 Hardware kit when power supply is OFF

Here there is a no target,hence the ultrasonic sensor will moves from extremely right to left with an angle of 0 degree to 180 degrees.

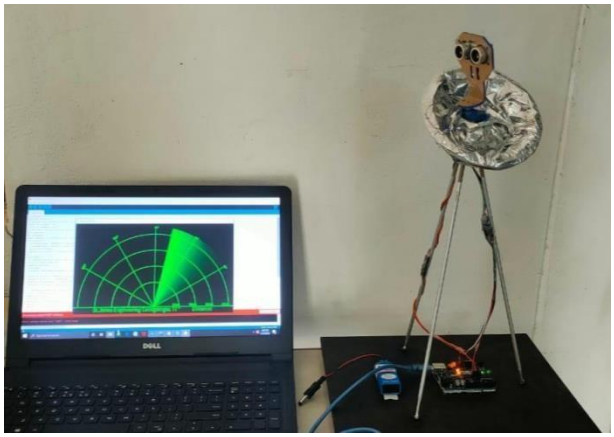

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Fig: 4 Target is not detected

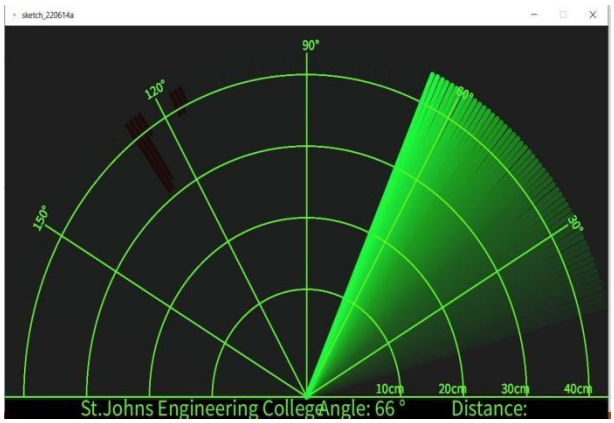

Fig: 5 Output of the Processing IDE's screen when the target is not detected

Here we assume a book as a target. When the ultrasonic waves hit the target ,it reflected back by emitting echos and it will be received by the receiver.

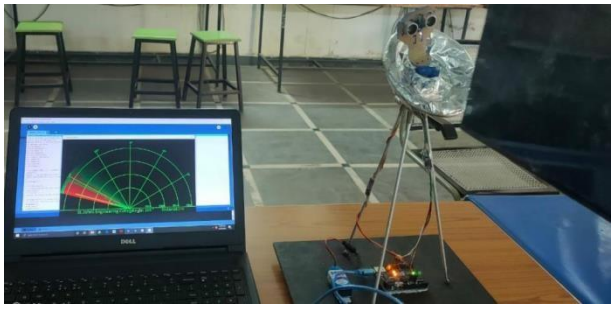

Fig:6. Target is detected

When the target is detected ,output of the stem displays both a direction in terms of angle and distance in centimeters in a Processing IDE Screen

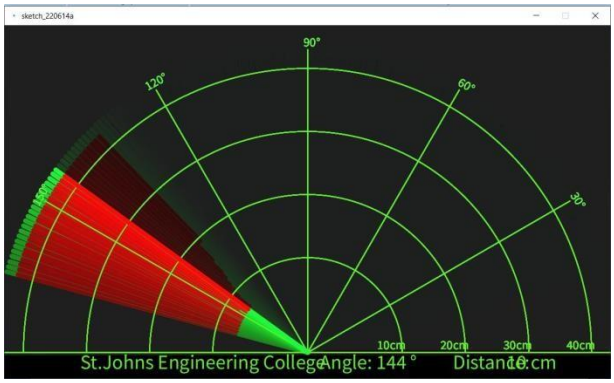

Fig:7. Output of the Processing IDE's screen when the target is detected

We get distance values in centimeters of ultrasonic sensor on a serial monitor screen of Arduino IDE's whether the target is detected or not detected.

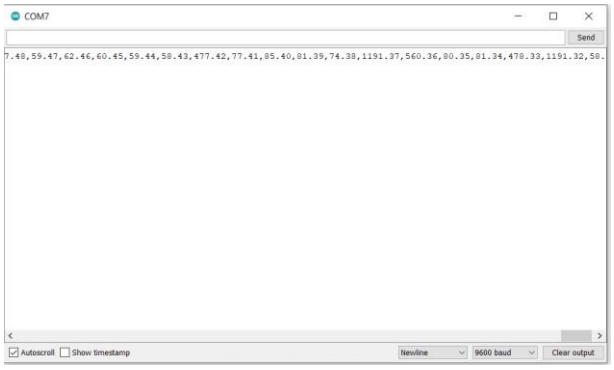

Fig: 8. Output in Arduino IDE's Screen

VI.Conclusion :

In our project, radar system was designed with the help of Arduino, servomotor and ultrasonic sensor which can detect the position, distance of obstacle which comes in its way and onverts it into visually representable form.Here the recommended Arduino based radar system mapping method of whole system is assessed on small principles or scale . The

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field that we have chosen for our design "Radar System" is a very vast field and future scope of this technology is very high. We have tremendous applications in which radar system have been implemented or used . There is a lot of future scope of this design because of its security capacity. It can be used in many applications. This framework can also be developed or modified according to the rising needs and demand.

VII. Future Scope:

There is a lot future scope of this project as modification with Wifi connection between Arduino and Android can be introduced in order to monitoring through internet. GPS can be introduced for security purpose. The project can be developed and modified according to the rising need and demands. Usage of a 360 degrees rotating servo motor can make the system more efficient. We look forward to modify this system and enhance our research work by using a fully 360 degrees rotating servo and a higher ranged ultrasonic sensor.

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