VISVESVARAYA TECHNOLOGICAL UNIVERSITY

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A Mini Project on

Ultrasonic Radar System

Submitted in partial fulfillment of the requirements for the award of the degree of

Bachelor of Engineering

in

Electronics and Communication Engineering

by

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CERTIFICATE

This is to certify that the mini project entitled **"Ultrasonic Radar System using Arduino And Ultrasonic sensor"** is carried out by **Akarsh A S (1KI20EC002), Anoop T S (1KI20EC004), Supreet V (1KI20EC039), Supreeth A L (1KI20EC040)**, the bonafide students of Kalpataru Institute of Technology, Tiptur in partial fulfillment for the award of "Bachelor of Engineering" in department of "Electronics and Communication Engineering" of the Visvesvaraya Technological University, Belagavi, during the year 2022-2023. It is certified that all the corrections/suggestions indicated for internal assessment have been incorporated in the report deposited in the departmental library. The mini project report has been approved as it satisfies the academic requirements in respect of mini project prescribed for the said degree.

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ABSTRACT

The application of radio detection and ranging in different places such as military installation, commercial use is done with the help of RADAR SYSTEM which uses electromagnetic waves for detection of different physical components such as distance, speed, position, range, direction, size etc which can be either fixed or be in motion.

Use of radar system has been developed greatly specially in field of navigation. In this research we study about existing navigation technologies and proposed an Arduino based radar system. It has advantage over other radar system as kit reduces power consumption and connect programmer to wide range or Arduino programmers and open source code.

The system consist a basic ultrasonic sensor placed upon a servo motor which rotates at a certain angle and speed. This ultrasonic sensor is connected to Arduino digital input output pins and servo motor also connected to digital input output pins.[1].

Current system is capable to detect any radiation in the range of track. The proposed system is based on Ultrasonic sensor. The ultrasonic sensor provides 2cm to 40cm of dimension functionality with a range precision that can measure up to 21m. Every ultrasonic sensor includes a spreader, a receiver and a control circuit

Radar System is an object recognition system that uses electromagnetic rays to recognize range, elevation, direction, or speed of both moving and fixed Objects. Objects can be such as air objects, under water objects, moving or fix vehicles, weather formations, and terrain. When we use ultrasonic rays except of electromagnetic waves, we call it Ultrasonic Radar. The main mechanism in any Object radar is the Ultrasonic Sensor. Ultrasonic works on the principle of Radar or Sonar which evaluate characteristic of object by construe the ricochet from radio or sound influence in that order.

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

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Chapter 1

INTRODUCTION

1.1 Literature survey

We know everything produces sound wave just by existence and effect flow of air around them with their natural frequency. These frequencies are beyond hearing range of humans. Wave of frequency range of 20kHz and thereabouts are called ultra-sonic wave and these waves can be detected by an ultrasonic sensor which helps us to get various knowledge.

An Ultrasonic detector usually has a transducer which convert sound energy into electrical energy and electrical energy into sound energy. They are used for measuring object position and orientation, collision avoidance system, surveillance system etc. Ultrasonic technology provide relief from problem such as linear measurement problem, as it allows user to get non-contact measurements in this way distance between object and its speed etc can me easily measured. Speed of travel of sound wave depends upon square root of ratio between medium density and stiffness. Also, property of speed of sound can also be changed by natural environment condition like temperature. So basically, an ultrasonic sensor sends ultrasonic waves which travels in air and gets reflected after striking any object. By studying the property of reflected wave, we can get knowledge about objects distance, position, speed etc.

A processing software and an Arduino software is used with hardware system for detection of objects various parameters. One of the most common application of ultrasonic sensor is range finding. It is also called as sonar which is same as radar in which ultrasonic sound is directed at a particular direction and if there is any object in its path it strikes it and gets reflected back and after calculation time taken to come back we can determine distance of object. in real life this method is used by bats.

1.2 Objectives

ULTRASONIC RADAR is an object-detection system which uses radio waves to determine the range, altitude, direction, or speed of objects. Ultrasonic Radar systems are used for air-traffic control at airports, and long range surveillance and early-warning systems. A radar system is the heart of a missile guidance system.

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Ultrasonic radar system is inspired by Bats.Bats navigate and find insect prey using echolocation. They produce sound waves at frequencies above human hearing, called ultrasound. The sound waves emitted by bats bounce off objects in their environment. Then, the sounds return to the bats' ears, which are finely tuned to recognize their own unique calls.

A processing software and an Arduino software is used with hardware system for detection of objects various parameters like direction , distances, speed etc.

Chapter 2

HARDWARE REQUIREMENT

2.1 Ultrasonic Sensor:

An ultrasonic sensor works similar as of sonar. It can measure distance of object by sending sound waves. Sound waves are send at a specific frequency at a specific direction and listen for sound wave to come back. time taken by sound wave to come back helps us to determine distance of object.

Most ultrasonic sensors are based on the principle of measuring the propagation time of sound between send and receive (proximity switch).The barrier principle determines the distance from the sensor to the reflector (retro-reflective sensor) or to an object (through-beam sensor) in the measuring range.

Figure 2.1: Ultrasonic Sensor.

They DO NOT measure farther than about 70 feet (21 meters). They DO NOT measure at very high repetition rates. Due to speed of sound limitations the fastest rate is 200 Hz at a max distance of about 24 inches.

2.2 Arduino Uno

The Arduino is an open source electronics platform based on easy to use hardware and software. The open source Arduino software makes it easy to write code and upload it to the board. It runs on Windows, Mac OS X and Linux. The environment is written in java and based on processing and other open source software.

This software can be used with any Arduino board. The Arduino software IDE contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common function. It connects to Arduino and Genuino hardware t+o upload programs and communicate with them. Program written using Arduino software are called sketches.

Figure 2.2: Arduino UNO R3.

It makes electronics accessible to non-engineers, hobbyists, etc. The various components present on the Arduino boards are Microcontroller, Digital Input/output pins, USB Interface and Connector, Analog Pins, Reset Button, Power button, LED's, Crystal Oscillator, and Voltage Regulator.

The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc and initially released in 2010.

2.3 Servo Motor

A servomotor is a rotary actuator that allows for precise control of angular position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servo motors.

Servomotors are not a different class of motor, on the basis of fundamental operating principle, but uses servomechanism to achieve closed loop control with a generic open loop motor. Servomotors are used in applications such as robotics, CNC machinery or automated manufacturing.

Figure 2.3: Servo Motor.

A servo motor is an electro-mechanical device that produces torque and velocity based on the supplied current and voltage. A servo motor works as part of a closed loop system providing torque and velocity as commanded from a servo controller utilizing a feedback device to close the loop.

The board is equipped with sets of digital and analog input/output pins that may be interfaced to various expansion boards and other circuits.

2.4 Bread board

A breadboard, solder less breadboard, or protoboard is a construction base used to build semi-permanent prototypes of electronic circuits. Unlike a perfboard or stripboard, breadboards do not require soldering or destruction of tracks and are hence reusable. For this reason, breadboards are also popular with students and in technological education.

Compared to more permanent circuit connection methods, modern breadboards have high parasitic capacitance, relatively high resistance, and less reliable connections, which are subject to jostle and physical degradation. Signaling is limited to about 10 MHz, and not everything works properly even well below that frequency.

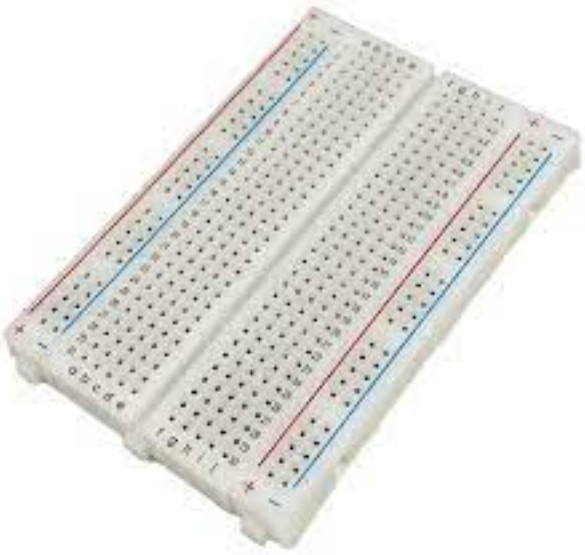

Figure 2.4: Bread board.

A modern solderless breadboard socket consists of a perforated block of plastic with numerous tin plated phosphor bronze or nickel silver alloy spring clips under the perforations. The clips are often called tie points or contact points. The number of tie points is often given in the specification of the breadboard.

The purpose of the breadboard is to make quick electrical connections between components-like resistors, LEDs, capacitors, etc- so that you can test your circuit before permanently soldering it together.

Chapter 3

SOFTWARE REQUIREMENT

3.1 Arduino UNO IDE Software

The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them.

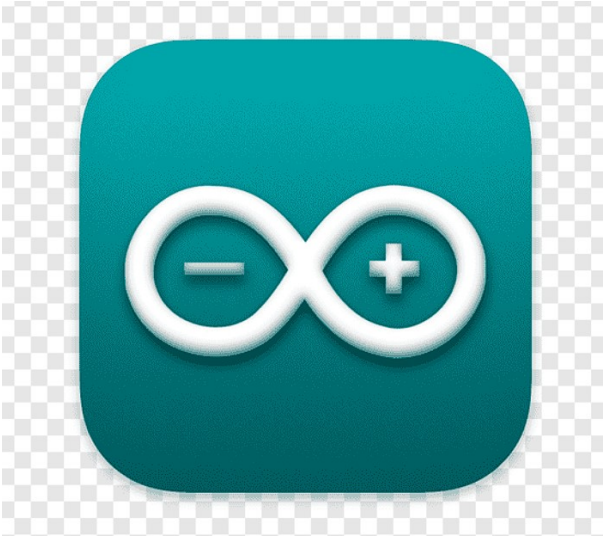

Figure 3.1: Arduino UNO IDE Software.

Programs written using Arduino Software (IDE) are called sketches. These sketches are written in the text editor and are saved with the file extension .ino . The editor has features for cutting/pasting and for searching/replacing text. The message area gives feedback while saving and exporting and also displays errors. The console displays text output by the Arduino Software (IDE), including complete error messages and other information.

The bottom righthand corner of the window displays the configured board and serial port. The toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and open the serial monitor.

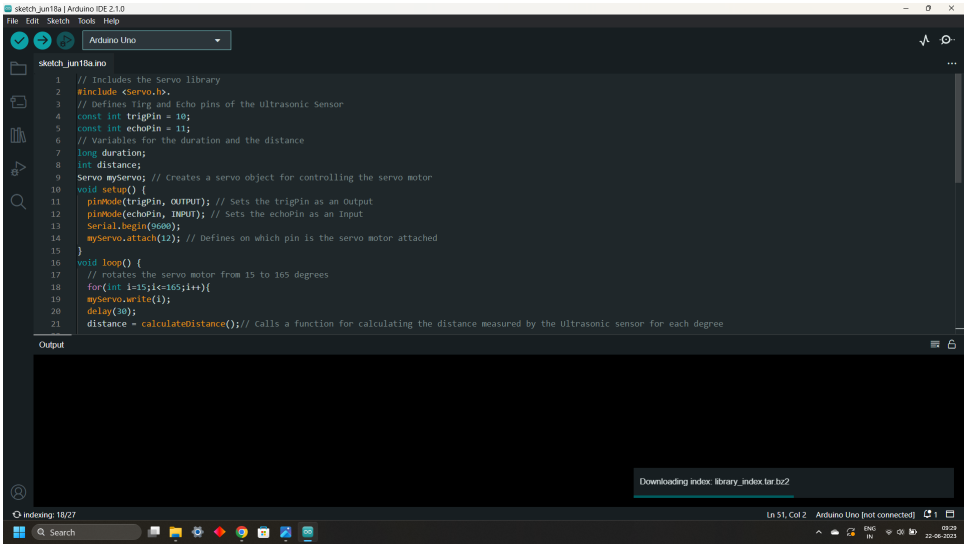

Figure 3.2: Arduino UNO IDE Software Interface.

Verify/Compile Checks your sketch for errors compiling it; it will report memory usage for code and variables in the console area. Upload Compiles and loads the binary file onto the configured board through the configured Port.

Upload Using Programmer This will overwrite the bootloader on the board; you will need to use Tools > Burn Bootloader to restore it and be able to Upload to USB serial port again. However, it allows you to use the full capacity of the Flash memory for your sketch.

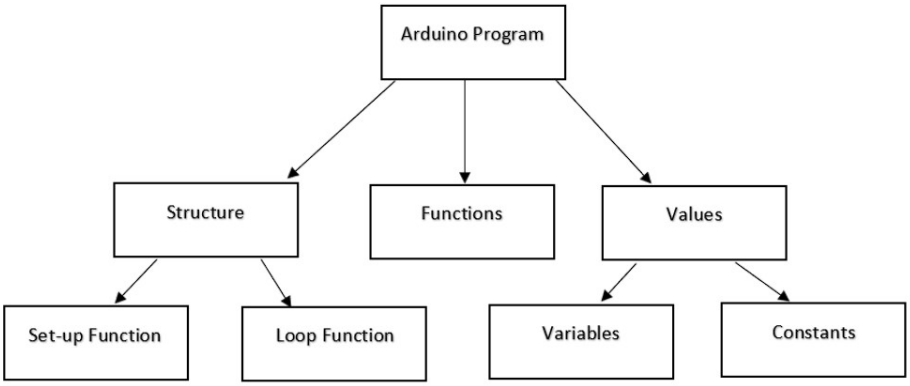

Figure 3.3: Arduino Programming is Divided into Three steps.

Arduino programs can be divided in three main parts: Structure, Values (variables and constants), and Functions. When writing a code, the important thing is following the syntax of the language being used because in order to run the code successfully the correct syntax is necessary.

3.2 Processing Software

Processing is a free graphical library and integrated development environment (IDE) built for the electronic arts, new media art, and visual design communities with the purpose of teaching non-programmers the fundamentals of computer programming in a visual context.

Figure 3.4: Processing Software.

Processing uses the Java language, with additional simplifications such as additional classes and aliased mathematical functions and operations. It also provides a graphical user interface for simplifying the compilation and execution stage.The Processing language and IDE have been the precursor to other projects including Arduino and Wiring.

Processing includes a sketchbook, a minimal alternative to an integrated development environment (IDE) for organizing projects. Every Processing sketch is actually a subclass of the PApplet Java class which implements most of the Processing language's features.

When programming in Processing, all additional classes defined will be treated as inner classes when the code is translated into pure Java before compiling. This means

that the use of static variables and methods in classes is prohibited unless Processing is explicitly told to code in pure Java mode.

Processing also allows for users to create their own classes within the PApplet sketch. This allows for complex data types that can include any number of arguments and avoids the limitations of solely using standard data types such as: int (integer), char (character), float (real number), and color (RGB, RGBA, hex).

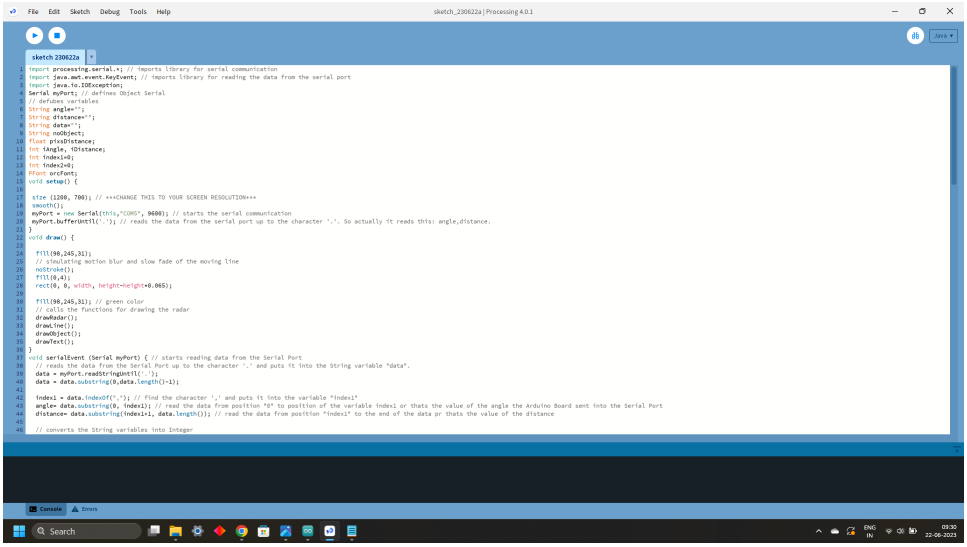

Figure 3.5: Processing Software Interface.

Processing has spawned another project, Wiring, which uses the Processing IDE with a collection of libraries written in the C++ language as a way to teach artists how to program microcontrollers. There are now two separate hardware projects, Wiring and Arduino, using the Wiring environment and language. Fritzing is another software environment of the same sort, which helps designers and artists to document their interactive prototypes and to take the step from physical prototyping to actual product.

Processing's core libraries, the code included in exported applications and applets, is licensed under the GNU Lesser General Public License, allowing users to release their original code with a choice of license.The IDE is licensed under the GNU General Public License.

Chapter 4

DESIGN OF ULTRASONIC RADAR SYSTEM

4.1 Design and Implementation of Radar System

As the name Object Radar indicates, ultrasonic sensors are used to calculate distance by using ultrasonic waves emitted by an ultrasonic module. The sensor skull sends out an ultrasonic signal and receives the signal replicated reverse from objective. Ultrasonic modules calculate the space to the object by determining the time among the emanation and response.

The figure shown below shows the development life cycle of Radar project which involves various step such as design of different components,their testing, their implementation and implementation of entire system and their testing. These steps can be enumerated into following stages

1) Hardware System Design.
2) Hardware Circuit Design.
3) Hardware System implementation.
4) Hardware unit testing.
5) GUI System Design.
6) GUI System Implementation.
7) GUI unit testing.
8) Entire system integration.
9) Entire system testing.

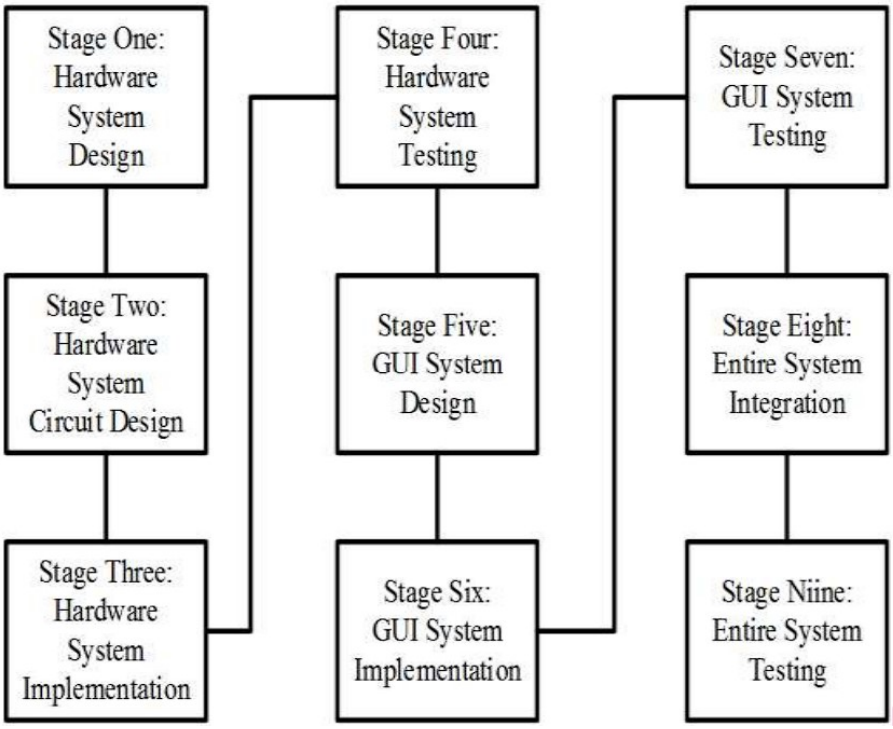

Figure 4.1: Development life cycle of Radar System.

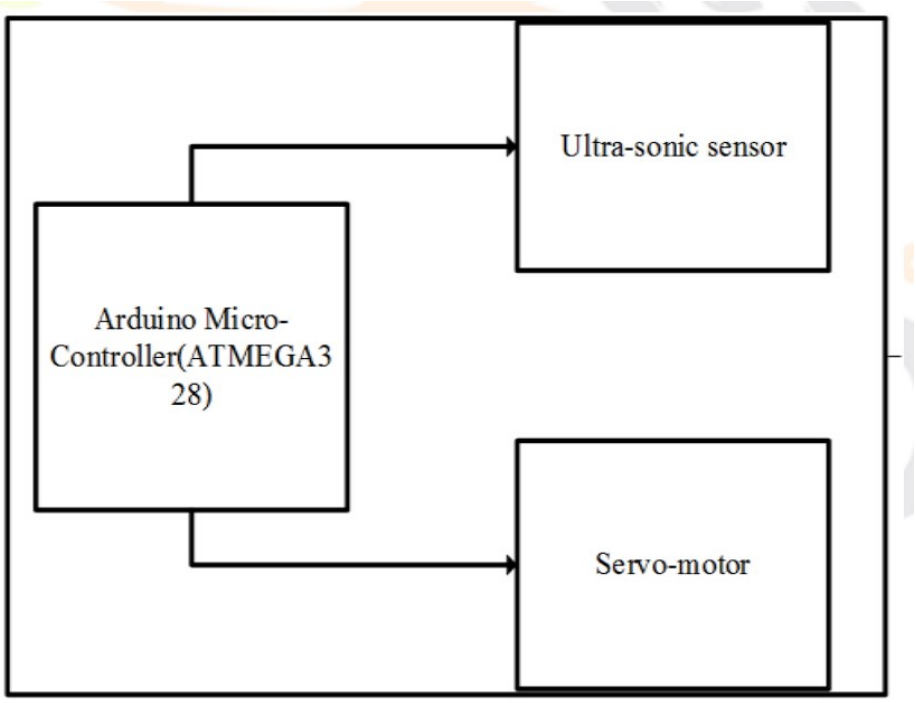

Figure 4.2: Hardware System Design of Radar System.

4.1.1 Hardware system design for Arduino

Hardware system consist of basically 3 components named as Arduino, servo-motor, and ultra-sonic sensor. Ultrasonic sensor is mounded upon a servo motor which helps it to move and provide it a turning mechanism. Both ultrasonic sensor and servo motor are controlled and powered by Arduino. As given in above figure we can see both ultrasonic sensor and servo motor is powered by Arduino.

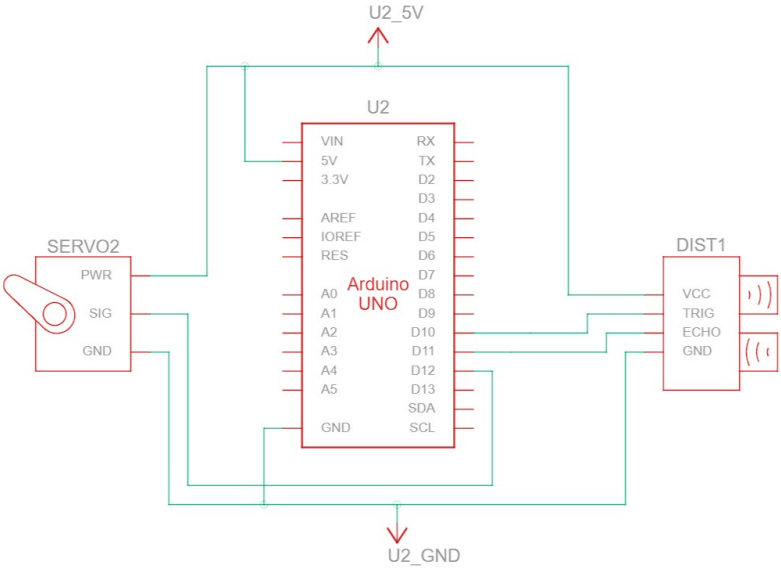

Figure 4.3: Block Diagram of Hardware System.

4.1.2 System circuit design

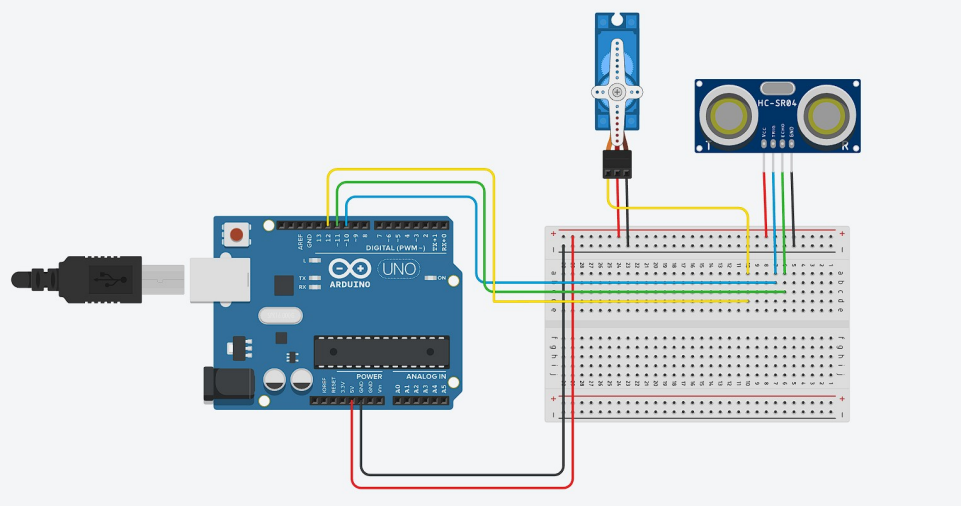

Figure 4.4: Hardware System Design.

Figure shows hardware system design which was designed using fritzing environment. It shows the connection of different electronics components. In the figure triggering pins of ultrasonic sensor is connected to D8 pin of Arduino, control line of servo motor is connected to D6 pin of Arduino and D7 pin of Arduino is connected to echo pin. VCC pins of servo motor and ultrasonic sensor is connected to 5V pin of Arduino while ground pin of Arduino is connected to ground pin of both servo motor and ultra-sonic sensor.

4.1.3 System circuit implementation on bread board

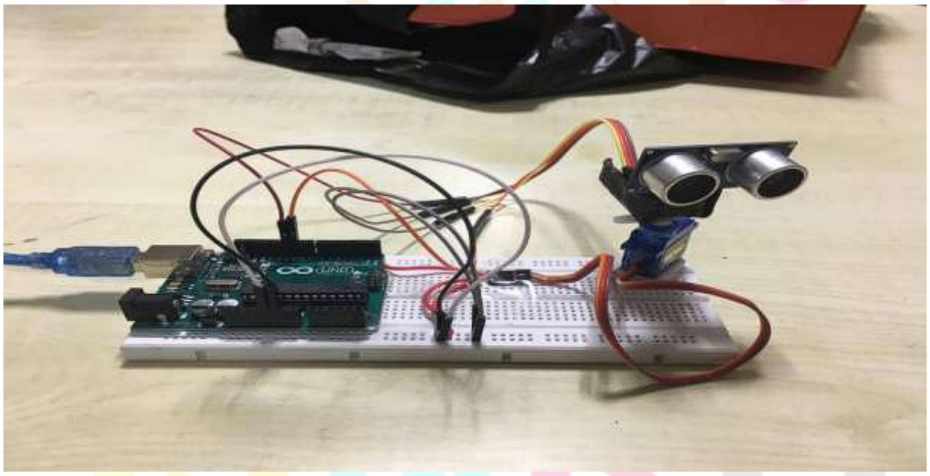

Figure 4.5: Breadboard of the Hardware System Implementation.

Above figure shows complete implementation of hardware system. It can be seen that ultrasonic servomotor is placed upon a servo motor and it is placed above bread board. Arduino is placed in breadboard in other side of the breadboard and entire connection is made between them.Arduino and servo motor are stick to breadboard to stop it from tripping over when servo motor moves. Arduino IDE was used to write code and upload it in Arduino. Arduino code reads position of servo motor and calculate distance of nearest object in the path.

Firstly, transfer the code to Arduino Board by serial cable after building the link connections. You can monitor the servo motor all encompassing from 0° angles to 180° angle and yet again back to angle 0°. as the Ultrasonic module is accumulate above the Servo, it will too take part in the all-encompassing exploit. Now, open the processing environment sketch. In the Processing Sketch, make needed alteration in the COM Port of device assortment and replace it with the COM Port number to which your Arduino is connected to.

4.1.4 Hardware system testing

A cable was used for connecting Arduino to develop developing machine. From Arduino IDE helped us to obtain result in serial monitor.

4.1.5 GUI system design and implementation

GUI was build in JAVA program language and it has 2 classes that are given in below diagram in figure.Object class of radar project represent object that it encounters such as distance, target/range and angle/direction of position of object.

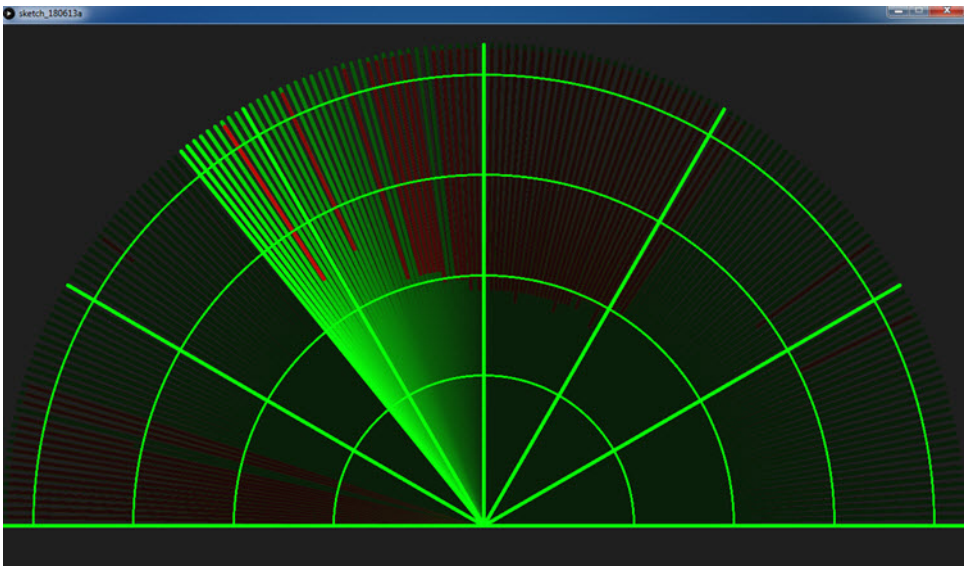

Figure 4.6: GUI Implementation for the Mapping Interface.

Distance ()method (), angle () method, location () method takes the required value such as distance, angle and makes them on GUI to do simulation.Figure 6 shows line sweep from one-direction to other and a smudge is made is GUI where ultrasonic sensor sense obstacles.

4.2 Working Principle

Insightful wave fields are tracked and a particular side pulse is discharged by the unbearable sensor where the device gets reverberated. An outcome signal can be incurred using a laptop, or a common place regulator or by relevant degree mechanism. This result can be directly used or altered.This functioning is depicted in the following figure.

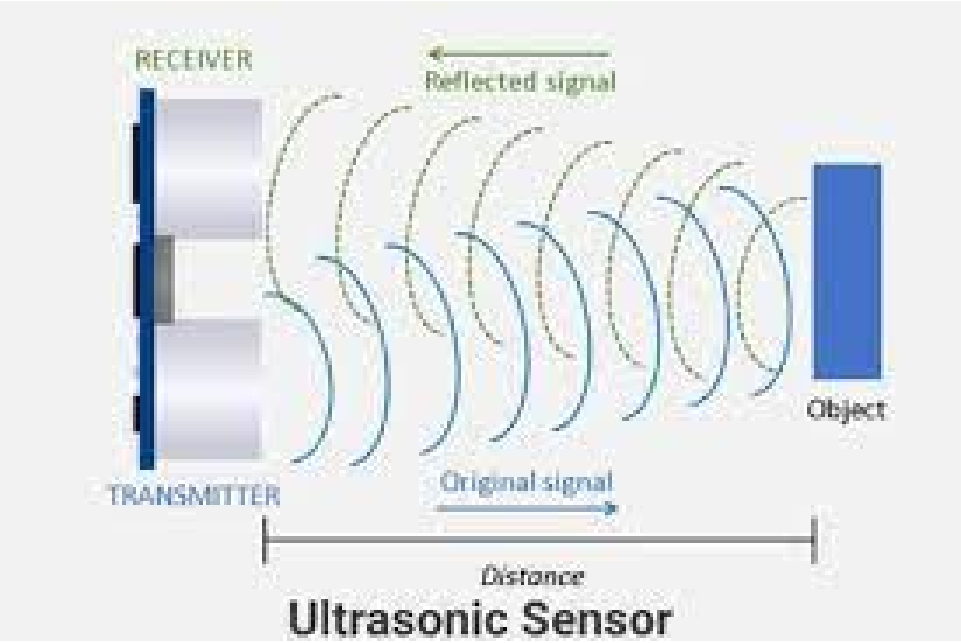

Figure 4.7: Working Principle.

The essential target of our arrange is to seek out out the gap position and speed of the snag set at some separation from the device. Unhearable device sends the ultrasonic wave in numerous manners by pivoting with help of servo engines. This wave goes in air and gets mirrored back ensuing to hanging some item. This wave is once more known by the device and its characteristics is poor down and yield is appeared in screen demonstrating boundaries, as an example, distance and position of item. Arduino IDE United Statesed is employed to make code and move writing in Arduino and makes us determine position or purpose of servo engine.

4.3 Working

The aim of this project is to calculate the distance position and speed of the object placed at some distance from the sensor. Ultrasonic sensor sends the ultrasonic wave in different directions by rotating with help of servo motor. This wave travels in air and gets reflected back after striking some object. This wave is again sensed by the sensor and its characteristics is analysed and output is displayed in screen showing parameters such as distance and position of object. Arduino IDE is used to write code and upload coding in Arduino and helps us to sense position of servo motor and posting it to the serial port along with the distance of the nearest object in its path.[2] The output of sensor is displayed with the help of processing software to give final output in display screen.[3]

4.4 Experimental Results And Conclusion

The experimental set up is explained clearly using the following diagram.The pin configuration and data modelling set is explained using the connection set up. Further the ultrasonic sensor configuration is also detailed using the setup. Executions of the sensors are done so that supersonic sensor is connected on top of the servo engine since it need to recognize the item and its distance.

Arduino (miniature regulator) will control the supersonic sensor and servo engine and furthermore fueled will be given to the two of them through miniature regulator.At the point when any snag/object is distinguished by the ultrasonic sensor the information is quickly handled by the regulator and is taken care of to the IDE which shows it on the presentation screen.Here the interaction closes with an expected distance of the article from the framework with the point at which it is put.

This system helps in detection of object which is at a distance of around 5 meters. And also calculate the distance at an angle of 0 to 180 degrees. Since this system uses ultrasonic signals that is sound waves, it is not affected by color. And due to its high sensitivity and high frequency, objects that are deep can be detected. When the detection is tested for objects of different material, the error recorded was less than 7 percentage.

If here is an object 10cm far as of the sensor, and the tempo of sound in the air is 340m/s or 0.034cm/s the echo signal will require passing through concerning 294 µs seconds. But what you will acquire from the Echo pin will be two times that number as the sound wave desires to travel onward and spring up toward the rear. So in sort to get the space in cm we require to increase the expected travel time worth from the echo pin by 0.034 and split it by 2.

The thought of making an Ultrasonic RADAR System come into sight to us while screening the technology used in security, be it Military, Fleet or Air Force and now also used in the automobile make use of features like routine/ automatic parking arrangement, disaster hindrance for the period of driving etc. Use of such has been seen in recent times in the auto car parking systems instigate by AUDI, FORD etc. And even the forthcoming mechanical cars by Google named Prius and Lexus.

The device prepared by us can be placed in any equip you may want to use like in an automatic car, a cycle mountain bike or all else. The draw on of Arduino board in the development gives the litheness of convention of the over said component according to the necessities.

4.5 Advantages And Applications

Instead of providing a different voltage source for operating ultrasonic sensor and servo motor, we have used supply from the micro-controller. By this way we reduced the cost of voltage supplies.[19]. It is also very easy to use and the ultrasonic sensors are available at low cost. It isn't influenced by shading or straightforwardness.

Fundamentally, the Ultrasonic Sensors communicate the sound off of the article, thus the tone and straightforwardness have no impact on the radar perusing. Any dim conditions have no impact on this Arduino radar sensor's location technique. Along these lines, it can likewise use around evening time. Simple to plan and low cost. The ultrasonic sensors are accessible at the market with modest cost. It has high recurrence, high affectability, along these lines, it can without much of a stretch distinguish the outer or profound items.

This radar sensor isn't influenced by dust, downpour, snow, and some more. The Arduino Radar Sensor is not difficult to utilize. Likewise, it is totally protected during the activity to close items, human or gear. The Ultrasonic sensor can without much of a stretch interface with any sorts of the microcontroller.

In aeronautics airships are prepared by means of radar systems that help airships or other objects in or forthcoming their way, forecasting weather conditions, and give exact elevation readings[4]. Airships with the Radar System can take off in foggy airports prepared with radar support ground illicit loom systems in which the airship's flight is pragmatic on radar monitor at the same time as operators' radio landing commands to the pilot.

In the Marine Devices Radar System can be used for determining the obstacles in the way of the Marines. By using the radar system in marines we can measure the bearing and the distance of other objects like Ships and others and the Radar System can be used to prevent the collision with the obstacles[5]. This can also be able to find the Islands, Buoys and Lightships.

In Army Fields two high range video cameras are used to automatically detect and are used to track the individuals' movements anywhere the system is located. But we can use the Radar System for the detection of the movement and any other activity then this can help us very broadly. Because in Army Fields cameras are not enough to observe the activities. And this may cause of low security in fields. So for this we can use Radar System. Because device do this by returning the signals to radar system with the movement distance and angle. This can help them to aim their guns easily towards the targets.

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