FORM 2

PATENTS ACT, 1970

(39 of 1970)

&

The Patents Rules, 2003

PROVISIONAL SPECIFICATION

(See section 10 and rule 13)

1. TITLE OF THE INVENTION

"ECHO SOUND BASED 360 DEGREES SURVEILLANCE RADAR SYSTEM"

2. APPLICANT(S)

3. Name : Punnam Omkaram, Dr. Pushpalatha Pondreti, Dr.B.Pragathi

a) Nationality : INDIAN

b) Address : University College Of Engineering(A)-Jawaharlal Nehru Technological University, Kakinada. SRF, Telangana

4. PREAMBLE TO THE DESCRIPTION

PROVISIONAL

The following specification particularly describes the invention and the manner in which it is to be performed.

4. DESCRIPTION

Technical Field of the Invention

The present invention pertains to the field of object detection, environmental mapping, and spatial awareness technologies. More specifically, it relates to the design and development of a system that employs ultrasonic sensors for detecting objects and mapping a 360-degree field of view in real-time. The invention is tailored for use in scenarios where light-free or low-light environments present challenges for traditional object detection systems, such as image processing or laser-based scanning techniques. By utilizing a combination of a microcontroller and a stepper motor, the system enables precise rotational scanning of the surroundings, while an ultrasonic sensor measures the distance to objects in its path.

The invention also includes a software component, using Processing IDE, for the graphical visualization of the detected objects. This software processes the distance and angular data, providing a clear representation of the surrounding environment, including the position and distance of objects relative to the system. The ability to detect objects dynamically, based on changes in distance measurements over time, further enhances its suitability for real-time applications.

This invention addresses the increasing demand for efficient, reliable, and cost-effective solutions for obstacle detection and mapping in autonomous vehicles, robotics, and environmental monitoring systems. By offering a straightforward yet robust approach, the invention provides an alternative to complex and expensive systems, enabling broad usability across various industries.

Background of the Invention

In the realm of modern sensing technologies, ultrasonic systems have emerged as pivotal tools for a wide array of applications ranging from industrial automation to environmental monitoring. Two prominent types of ultrasonic-based systems are the Ultrasonic Radar System and the Ultrasonic Mapping System. Both leverage the principles of sound wave propagation through various media to detect objects, measure distances, and map the environments. These systems are crucial in scenarios where traditional methods like optical or infrared sensors may be ineffective due to visibility restrictions, such as in low light conditions, opaque materials, or in environments with dust, smoke, or fog.

Moreover, their non-invasive nature and relatively low cost have driven significant interest in their adoption across sectors including robotics, autonomous vehicles, and structural monitoring. The Ultrasonic Radar System functions on the principle of emitting high-frequency sound waves (ultrasonic waves) that travel through air, water, or solid materials, and then measuring the time it takes for these waves to reflect from an object or surface. This time-of-flight (ToF) measurement provides valuable data for determining the distance to the object, much like traditional radar systems that use electromagnetic waves. Ultrasonic radar has the advantage of being highly effective in detecting objects at shorter ranges with high precision.

This makes it ideal for applications such as obstacle detection in autonomous robots, ranging in industrial control systems, and even in underwater navigation. Unlike optical radar or LIDAR, which can be affected by light interference or physical obstructions, ultrasonic radar is highly resistant to environmental factors like smoke, fog, and dust. Furthermore, its ability to penetrate different materials, such as concrete or soil, expands its applicability to areas like structural health monitoring and geological exploration.

Brief Summary of the Invention

A radar system that incorporates the Internet of Things (IoT) and uses ultrasonic sensors to identify objects within a 150-degree range. The rotation of the system is managed by a servo motor, and the detection results are shown on a Graphical User

Interface (GUI) created with Java Swing and applets. Traditional radar systems are indeed powerful, but they often come with high costs and complexities that can restrict their use in different areas. In light of these limitations, this research aims to design and implement a radar system utilizing Arduino microcontrollers and ultrasonic sensors.

This creative approach takes advantage of the versatility and cost-effectiveness of the Arduino platform, along with the accurate distance measurement capabilities of ultrasonic sensors, to develop a radar-like system. The research focuses on creating hardware, acquiring data, processing signals, and visualizing results in real-time, offering an affordable and user-friendly option for radar-based applications. An ultrasonic sensor is connected to a servo motor that can rotate about 180 degrees, offering a visual display on the Processing IDE software. In addition to the graphical display, the Processing IDE provides information on the angle, position, and distance of the object.

Arduino simplifies the management of this system. The Arduino UNO board is adequate for both interface development and ultrasonic sensor and display device control. Additionally, a buzzer alarm will sound if any unauthorized presence is detected. The Arduino Uno activates the buzzer and warning screen, which are connected to a sensor or motor for monitoring purposes. The radar keeps watching the area of 180 degrees all the time by listening for echoes with the ultrasonic sensor. Similarly, in the automotive industry, explored the integration of ultrasonic sensors with AI algorithms to enhance detection accuracy in autonomous vehicles, underscoring their critical role in safety features.

Industrial applications have also seen innovations in integrated ultrasonic sensors with machine learning techniques to predict and avoid potential collisions in dynamic environments. Ultrasonic sensors, which emit high-frequency sound waves and measure their echoes to calculate distances, have been extensively applied in various fields. An advanced ultrasonic sensor array system for precise indoor navigation, showcasing significant improvements in obstacle detection and avoidance capabilities. This has created new opportunities for the creation of numerous applications, such as security, surveillance, and environmental monitoring.

Since they offer a dependable and economical way to identify and track things within a given range, radar systems in particular have attracted a lot of attention in these domains. The development of radar systems has seen a rise in the use of ultrasonic sensors because of their increased popularity. An advanced guide cane that guides the user in both outdoor and indoor environments thanks to a global positioning system (GPS) and an obstacle detector system based on an ultrasonic sensor. An optimized PID control algorithm for servo motors, improving their performance in radar systems.

Ultrasonic sensor and also the visualization is made in the android smartphone which is seen in everyone’s pocket. The system can detect any obstacle or intruder which are in the sensor radius, measure the distance and it position, then displays in the android mobile with smart application. Industries have concentrated on developing new systems for mapping and exploring uncharted areas to establish advanced guidance systems for robots and individuals with disabilities. In particular, the most common applications are related to the exploration of unknown or dangerous spaces that are not accessible to people by a new low-cost system namely ultrasonic radar system (URAS), to automatically map environments using an ultrasonic sensor and show the collected information on an Android-based device.

Robot module, which is a physical support for the independent module and composed of servomotors remotely controlled by an android based Smartphone. design and implementation. To designing a system for object detection and map the detected objects using ultrasonic sensors in a 360-degree field of view there are mainly two major things to consider they are control device and rotating device where ATMEGA328P AVM RISC system on chip microcontroller with 16M Hz crystal oscillator is chosen for control of entire system operation, stepper motor is used to cover 360-degree field of view with ultrasonic sensor is mounted on the stepper motor shaft which make it rotate 360 degrees.

stepper motor shaft makes 64 steppes in clock wise direction for one cycle of rotation (i.e. 360 degree) and it make counter clock wise direction another 64 steppes to get back to initial position. Stepper motor is operated with the ULN2003 stepper motor driver with LED indicators of each input pulses. The entire design is supplied with 5 volts dc supply with LM7805 voltage regulator to regulate the 12 V to 5 V, by providing 12 V supply from external source. States LED provided to know power is available or not and slide swathes are used with LED to start-stop and range selection for stepper motor and ultrasonic sensor respectively. Inter integrated communication (I2C) module is used for 16*2 liquid crystal display (LCD) to display the distance and angle of the detected object in radar range.

Rader range is varied with the range selection slide switches when switch is on blue LED will indicated say ‘1’ else in off state LED will not glow indicated say ‘0’. If sensor is detected any object in particular direction, then the buzzer will make sound with distance and angle is displayed in LCD. A Bluetooth module HC-05 is provided to transfer the output to the PC to display the output in monitor with object that detected by the radar system. Processing IDE is used for the GUI to show the output of the system.

Microcontroller is coded to control the system as shown in fig-1 when the system is on then basing on the start-stop switch microcontroller start ultrasonic sensor and stepper motor if start-stop is off position then stepper motor initiate the stop process which make the stepper motor to get back to initial position by two possible ways one is stepping in anti-clock wise direction this will takes place by changing its direction from its actual direction when the motor is stepping in clock wise direction this process can say initialization in backward stepping

Brief Summary of the Drawings

The invention will be further understood from the following detailed description of a preferred embodiment taken in conjunction with an appended drawing, in which:

Fig.1 illustrates the flow chart for ATMEGA328P microcontroller and processing application.

Fig.2 illustrates the system components.

Fig.3 illustrates the detected objects represented on the system LCD screen.

Fig.4 illustrates the detected objects represented in processing application.

Fig.5 illustrates the modes of operating range.

Fig.6 illustrate the angle and distance detected by sensor.

Detailed Description of the Invention

To designing a system for object detection and map the detected objects using ultrasonic sensors in a 360-degree field of view there are mainly two major things to consider they are control device and rotating device where ATMEGA328P AVM RISC system on chip microcontroller with 16M Hz crystal oscillator is chosen for control of entire system operation, stepper motor is used to cover 360-degree field of view with ultrasonic sensor is mounted on the stepper motor shaft which make it rotate 360 degrees.

Stepper motor shaft makes 64 steppes in clock wise direction for one cycle of rotation (i.e. 360 degree) and it make counter clock wise direction another 64 steppes to get back to initial position. Stepper motor is operated with the ULN2003 stepper motor driver with LED indicators of each input pulses. The entire design is supplied with 5 volts dc supply with LM7805 voltage regulator to regulate the 12 V to 5 V, by providing 12 V supply from external source.

States LED provided to know power is available or not and slide swathes are used with LED to start-stop and range selection for stepper motor and ultrasonic sensor respectively. Inter integrated communication (I2C) module is used for 16*2 liquid crystal display (LCD) to display the distance and angle of the detected object in radar range. Rader range is varied with the range selection slide switches when switch is on blue LED will indicated say ‘1’ else in off state LED will not glow indicated say ‘0’. If sensor is detected any object in particular direction, then the buzzer will make sound with distance and angle is displayed in LCD.

A Bluetooth module HC-05 is provided to transfer the output to the PC to display the output in monitor with object that detected by the radar system. Processing IDE is used for the GUI to show the output of the system. Microcontroller is coded to control the system as shown in fig-1 when the system is on then basing on the start-stop switch microcontroller start ultrasonic sensor and stepper motor if start-stop is off position then stepper motor initiate the stop process which make the stepper motor to get back to initial position by two possible ways one is stepping in anti-clock wise direction this will takes place by changing its direction from its actual direction when the motor is stepping in clock wise direction this process can say initialization in backward stepping.

Another possible way is stepping is continued in anti-clock wise in its forward direction of motor without interrupting or changing its direction from actual direction of motor this process can say initialization in forward stepping. If start-stop switch is on position say true or high then stepper motor will start in clock wise direction and at each step HC-SR04 module will check for any obstacles. if any, distance and corresponding angle measured and send to the processing application to graphical representation of the radar with detected objects. Stepper motor steppes clock wise direction until 64 steps i.e.360 degrees and change its direction to step in anti-clock wise direction to get back to initial position each step tacks 128 ms and total 128 steps are made in one cycle with 16384 ms.

Proposed system work with 12 volts DC supply with enough power, green LED will glow. Then to ON the system ON_OFF switch is slide to right side then the system is powered. Before switch on the system select the operating ranges by sliding to up word direction say '1' (true) or down word direction say '0'(false) according to required range by reference of table-1. If $S2$ $S1$ $S0$ is 0 0 1 configured the system then the indicating lights will glow for evert true or '1' states with the HC-SR04 are initialized by fixed setup of minimum range 2 cm to maximum range 50 cm as shown in table-1.

To start system, start-stop switch is slide to right side say is as true or '1'. Then the stepper motor start stepping in clock wise direction in every step HC-SR04 will check for any object in the fixed range until 64 steps, each step angle is 5.625 degrees to cover 360 degrees by 128 ms delay in each step. When the stepper motor reaches the 360 degrees in clock wise direction then it self-starts stepping in anti-clock until 64 steps with each step angle is 5.625 degrees steps to cover 360 degrees by 128 ms in each step then reaches the initial position this process is continued until start-stop is set to OFF position by sliding to left side say false or '0' with indicating of red light.

Then stepper motor performs stop process where if the stop process is initializing when stepper motor is in clock wise stepping it change its direction and steppes to words initial position with anti-clock wise direction by 64 ms delay in each step. If stepper motor is stopped in anti-clock stepping then continues it's stepping to words the initial position by 64 ms delay in each step.

Proposed system is designed with the manually position correcting, it will use full if the power interrupted while in working the initial position will be changed to current position which may not as required position so to correct this, select switches are configured to 1 1 1 and start-stope switch is in OFF position then the ON_OFF switch is ON then stepper motor will start stepping in anti-clock wise direction with 2 s delay in each step to give time turn OFF the system with ON_OFF switch when required position is reached by Stepper motor.

Output of the proposed system is can observed in LCD and the output data is send to the PC trough Bluetooth then processing application will render the radar GUI according to given inputs. To paring the Bluetooth with PC, turn on the PC Bluetooth then power on the devise with pressing the Bluetooth reset button which will indicating led will on and off with 2s delay then scan for the new device in PC name with end HC-05 and the Bluetooth password is “VLSI” then Bluetooth will connect to PC successfully. Buzzer in the system will make audible sound to indicate that an object is detected in the operating range. Fig-2 shows the proposed system components.

Successful implementation of the project involved the integration of several hardware components, including the Servo motor, and Ultrasonic sensor, Bluetooth module and LCD screen. In this design used 16*2 LCD screen to display the result near the radar system shown in fig-3 and software tools utilized to display the results from remotely in Processing application shown in fig-4 and distance measured by the sensor at different angle with corresponded step is tableted in fig.5.

The echo sound radar project using ultrasonic sensors is an engaging and informative endeavor. It provides a foundational understanding of radar technology and sensor integration. While it has limitations, these can be addressed through improvements in range, accuracy, and object detection. With the right enhancements, this project has the potential to become a versatile and valuable tool for numerous applications, making it an exciting project for both learning and innovation in radar technology.

5. CLAIMS

I/We Claim:

1. A system for object detection and 360-degree mapping using ultrasonic sensors, comprising:

   A microcontroller (ATMEGA328P AVM RISC system on chip) with a 16 MHz crystal oscillator configured to control the system operation;

   A stepper motor with a ULN2003 stepper motor driver, capable of rotating an ultrasonic sensor in 64 steps clockwise and counterclockwise to scan the surrounding environment;

   An ultrasonic sensor (HC-SR04) mounted on the stepper motor shaft, configured to measure the distance of objects within a defined radar range;

   A Bluetooth module (HC-05) to wirelessly transmit the detected object data to a PC for remote visualization through Processing IDE.

2. The system of claim 1, wherein the radar range of the ultrasonic sensor is adjustable using slide switches with blue LED indicators denoting the active state, allowing customization of minimum and maximum detection ranges.

3. The system of claim 1, wherein the stepper motor operates with a delay of 128 ms per step to ensure precise object detection and completes 360-degree scanning in 64 steps clockwise before reversing direction to return to the initial position.

4. The system of claim 1, further comprising:

   A 16x2 LCD display interfaced using an I2C communication module to display the distance and angle of detected objects in real time;

   A buzzer configured to produce an audible alert when an object is detected within the radar range.

5. The system of claim 1, wherein the microcontroller is programmed to stop the stepper motor and reset it to its initial position using two modes:
Reverse stepping in an anti-clockwise direction; or
Continuing in a forward stepping direction to the initial position, without interrupting the motor's natural motion.

6. The system of claim 1, wherein manual position correction is achieved by configuring the slide switches to a specific state (1 1 1), enabling the stepper motor to step in an anti-clockwise direction with a 2-second delay per step, allowing precise manual adjustments after power interruptions.

7. The system of claim 1, wherein the Processing IDE application renders a graphical radar interface displaying the detected objects, their distance, and angle in real time, enhancing user interaction and visualization of the mapped environment.

6. DATE AND SIGNATURE

P. Omkaram.

Dated this on 24/01/2025

Signature

<u>Title:</u> "ECHO SOUND BASED 360 DEGREES SURVEILLANCE RADAR SYSTEM"

7. ABSTRACT

The application aims at designing a system for object detection using ultrasonic sensors and mapping in 360-degree field of view and visualize the surrounding in remotely. The system uses a microcontroller to control a stepper motor that rotates an ultrasonic sensor, allowing it to scan the environment in all directions. The sensor measures the distance of objects in its path and displays this information visually through software called Processing IDE. Processing IDE gives graphical representation of angle or position of the object and distance of the objects, in the computer which processes this data to represent the detected objects of the surroundings. The system can also detect objects by identifying changes in the distance measurements over time. The proposed system is suitable for various applications such as obstacle avoidance, navigation, and environmental monitoring. Recently, Autonomous vehicles and robots are mostly concentrating on obstacle detection in simplest way and also to map 360 degrees surrounding with light free system, one of way in this aspect is using an ultrasonic sensor base system is the easiest way than using other methods like image processing, laser scanning systems.

The figure associated with the abstract is Fig. 1.

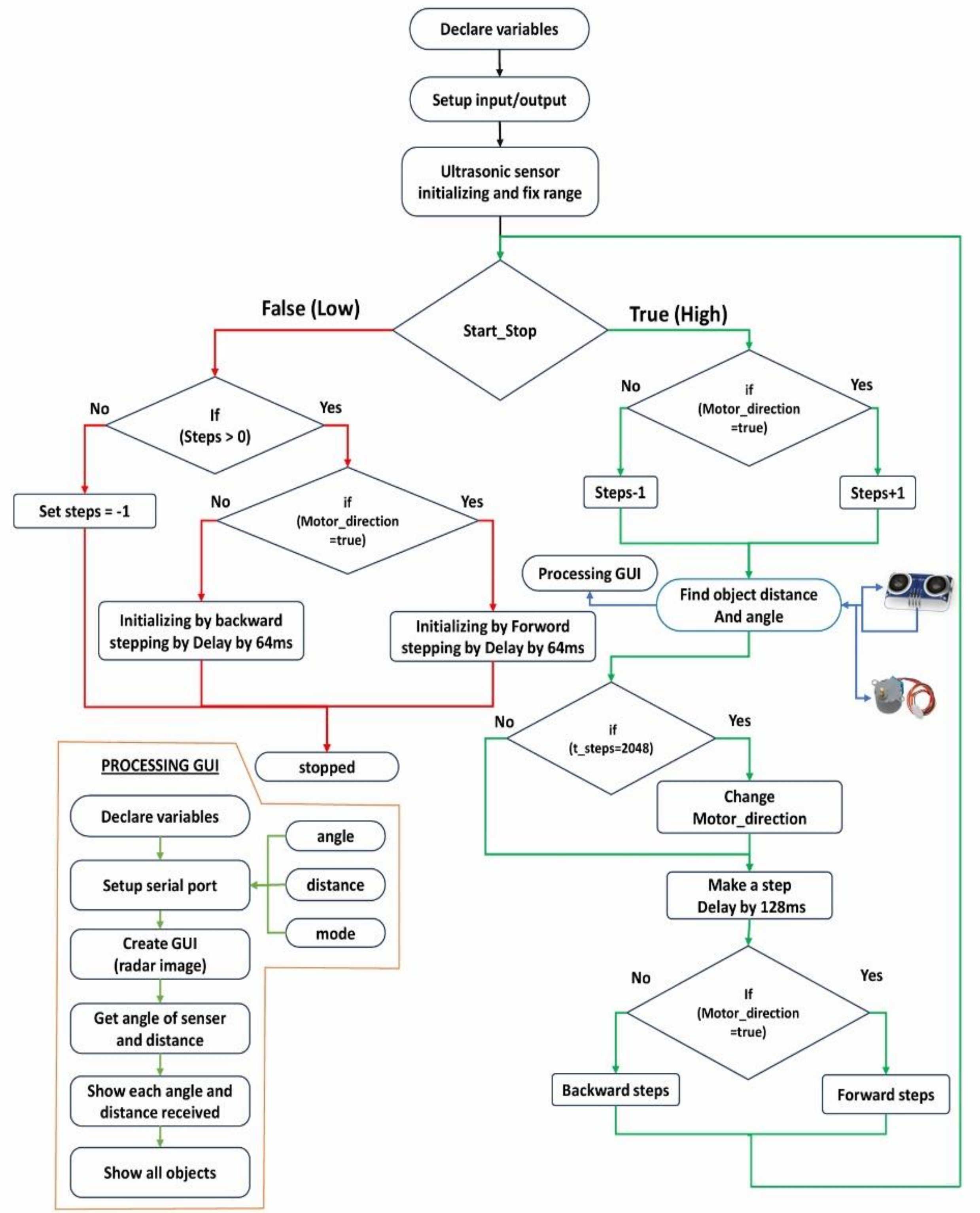
Declare variables
Setup input/output
Ultrasonic sensor initializing and fix range
False (Low)
Start_Stop
True (High)
No
If (Steps > 0)
Yes
Set steps = -1
No
if (Motor_direction =true)
Yes
Initializing by backward stepping by Delay by 64ms
Initializing by Forword stepping by Delay by 64ms
stopped
No
if (Motor_direction =true)
Yes
Steps-1
Steps+1
Processing GUI
Find object distance And angle
No
if (t_steps=2048)
Yes
Change Motor_direction
Make a step Delay by 128ms
No
If (Motor_direction =true)
Yes
Backward steps
Forward steps
PROCESSING GUI
Declare variables
Setup serial port
angle
distance
mode
Create GUI (radar image)
Get angle of senser and distance
Show each angle and distance received
Show all objects

Fig.1

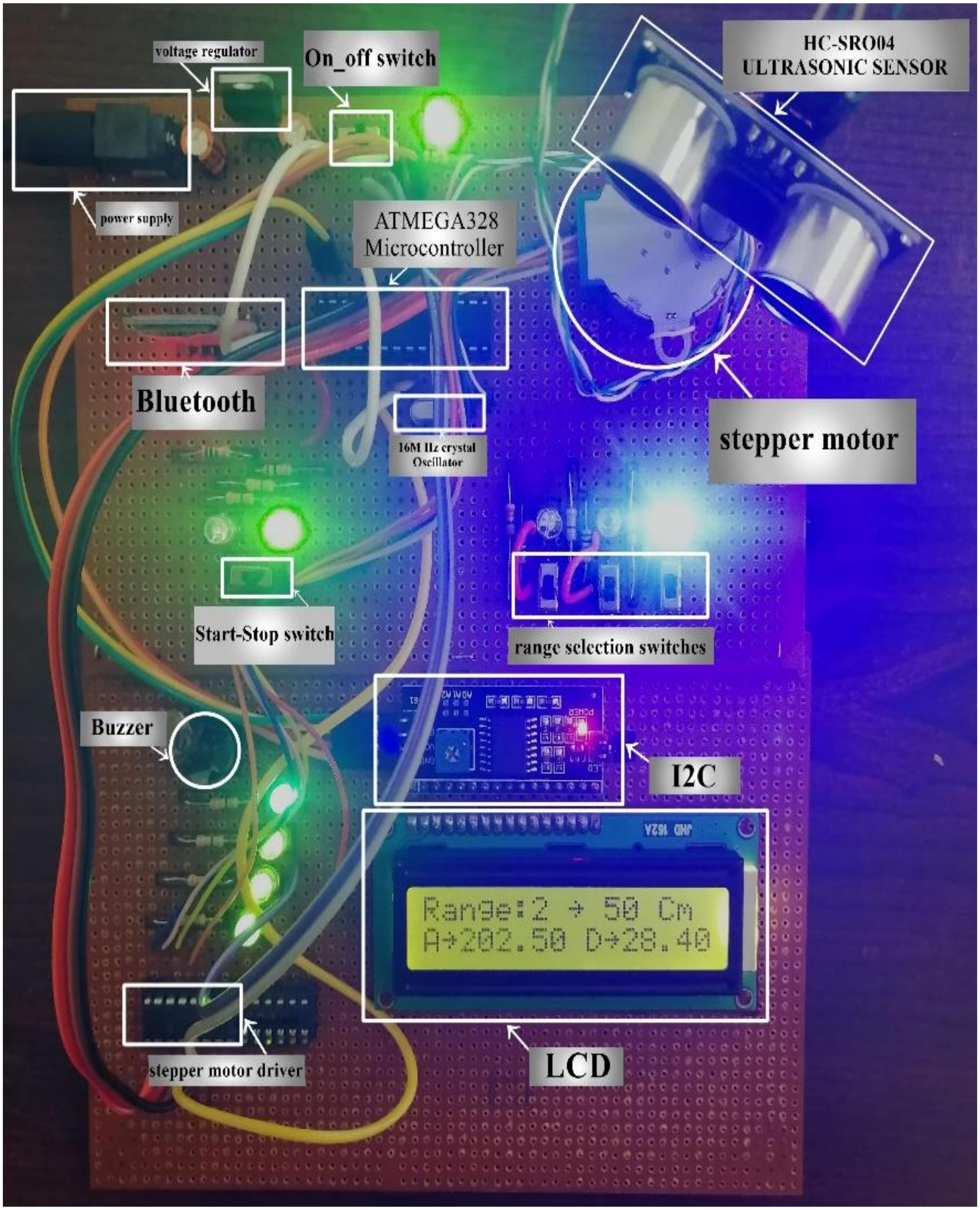
voltage regulator
On_off switch
HC-SRO04
ULTRASONIC SENSOR
power supply
ATMEGA328
Microcontroller
Bluetooth
stepper motor
16M Hz crystal
Oscillator
Start-Stop switch
range selection switches
Buzzer
I2C
Range:2 → 50 Cm
A→202.50 D→28.40
stepper motor driver
LCD

Fig.2

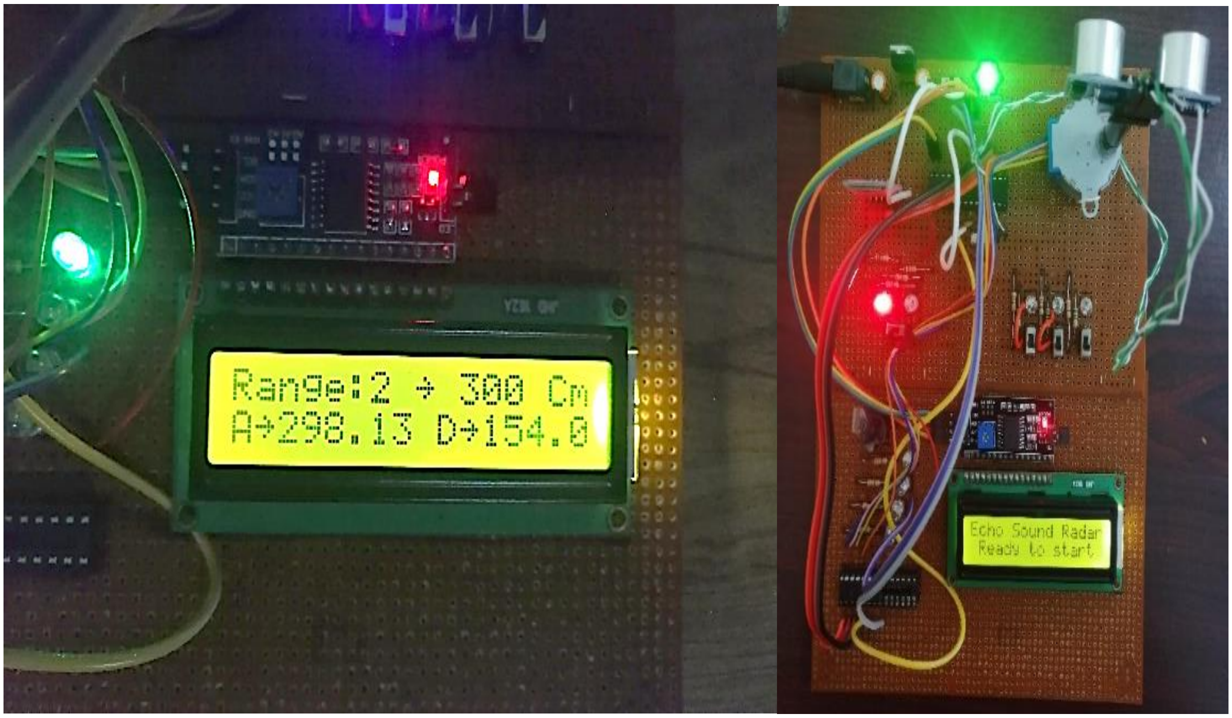
Range:2 → 300 Cm
A→298.13 D→154.0
Echo Sound Radar
Ready to start

Fig.3

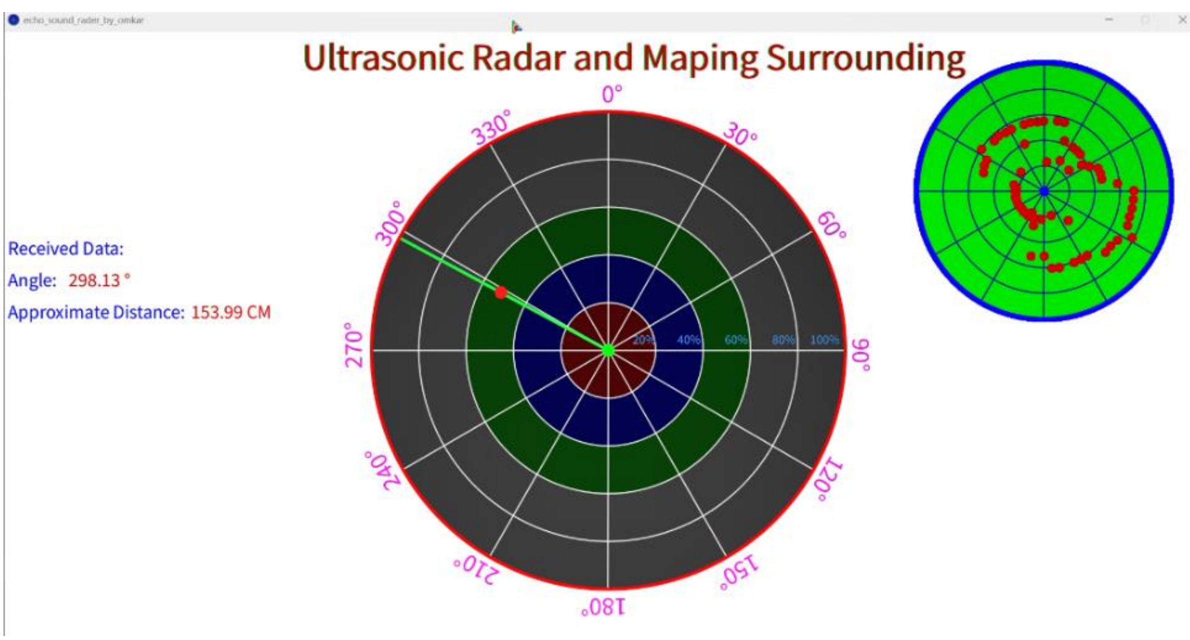
Ultrasonic Radar and Maping Surrounding
Received Data:
Angle: 298.13 °
Approximate Distance: 153.99 CM
0°
30°
60°
90°
120°
150°
180°
210°
240°
270°
300°
330°
20%
40%
60%
80%
100%

Fig.4

S. No:	Start-stop switch state	Range selection switches state (S_2 S_1 S_0)	Operation range	Stepper motor Direction
1	1	0 0 0	2cm to 10cm	clock wise
2	1	0 0 1	2cm to 50cm	clock wise
3	1	0 1 0	2cm to 100cm	clock wise
4	1	0 1 1	2cm to 200cm	clock wise
5	1	1 0 0	2cm to 300cm	clock wise
6	1	1 0 1	2cm to 400cm	clock wise
7	1	1 1 0	2cm to 400cm	clock wise
8	1	1 1 1	2cm to 400cm	clock wise
9	0	1 1 1	stepping with 2s delay.	Anti-clock wise

Fig.5

S. No:	Steps	Angle of sensor (degrees)	Distance sensed (Cm)
1	0	0	164.31
2	8	45	124.8
3	16	90	215.7
4	24	135	99.3
5	32	180	56.31
6	40	225	66.69
7	48	270	68.61
8	56	315	151.89
9	64	360	164. 31

Fig.6