

SURE TRUST



Project report on
**“Distance measurement using Ultrasonic sensor on
Arduino Uno”**

Internship report submitted in partial fulfilment of award of the certificate of
Embedded System course

From

Sure Trust

SUBMITTED BY

JAMEEL AHMED KUSTAGI

(Group G7 ES)

ABSTRACT

- The News reports estimates that 1 in 5 car accidents occur in the parking lot. It may be a head-on, rear-end, or T-bone crash. Since these occur in the parking lot, the vehicle's speed is low, and possibly the passengers remain safe. But in some circumstances, they could be fatal.
- Studies say parking accidents are mostly due to drivers' distractions caused by using mobile phones.
- In a parking lot, pedestrians move freely, and the driver has to remain alert even about their blind spots.
- We designed a system using the ultrasonic sensor that could be deployed in a Vehicle. The ultrasonic sensor is used to detect objects in blind spots.
- A blind spot is an area near the vehicle where the driver has low or zero visibility.
- The ultrasonic sensor works similarly to bats. Like bats, the ultrasonic sensor transmits ultra-frequency waves and measures the distance of the obstacle from the vehicle.
- These sensors can accurately detect objects and don't require any lighting. When the object is very close, it could signal the driver to become alert. Thus, it assists drivers in moving safely in a parking lot.

CONTENTS

List of tables List of figures

1

INTRODUCTION

1.1 General Background	10
1.2 Global Scenario	11
1.3 Problem Statement	12
1.4 Motivation of the project	13

2

Literature Survey 14

3

PROJECT DESCRIPTION

3.1 Existing Methodology	17
3.2 Proposed Methodology	18
3.3 Block Diagram	19

4

Simulation and Hardware

4.1 List of the components	20
4.1.1 Jumper Wires	20
4.1.2 Arduino Uno R3	21
4.1.3 Ultrasonic sensor(HC-SR04)	23

	4.2 Hardware Connection	30
	4.3 Simulation Model	31
	4.4 Arduino Program	32
	4.5 Simulation Output using tinkercad software	36
	4.6 Arduino IDE program Execution	37
5	CONCLUSION AND FUTURE SCOPE	38

List of figures

Figure No .	TITLE
4.1.1	Jumper wires
4.1.2	Aurdino UNO R3 Board
4.1.3	Ultrasonic Sensors
4.1.3.2	Timing Diagram
4.1.4	16x2 LCD Display
4.1.8	Breadboard
4.3 a	Circuit Diagram
4.3 b	Simulation Model
4.5	Simulation Output

List of tables

TABLE NO	TITLE
4.1.2.1	Pin details – aurdino UNO
4.1.2.2	Technical deatails aurdino UNO

CHAPTER 1

INTRODUCTION

1.1 General Background

During the 18th century, the electro-optical distance meter's development has evolved through the techniques of determining the velocity of light. Fizeau, who determined the velocity of light in 1840s, and a lot more inventions; E. Bergstrand was then inspired to design the first "Geodimeter" in 1940s. This works has developed and evolved throughout the history by aspiring Scientists. Moreover, recent scientists first patent application for an electromagnetic distance meter, this was made by Löwy in 1923. The use of this ultrasonic distance measuring device is useful in measuring the distance between two objects. Instead of using devices such as a measuring tape, an ultrasonic device can determine the length between two points of up to 4 meters. The researchers have decided to conduct this study to create a prototype of an ultrasonic distance measuring device and study and understand the basic concepts of using ultrasonic as a method of measuring distance. The concepts on how coding works when using Arduino UNO, ultrasonic distance measurement, Sonar, etc., This project will be useful in measuring two points; this device uses the concept of a sonar to determine the distance of an object.

Distance measurement is a crucial aspect of science and technology, enabling us to determine the distance between two points or objects. It plays a vital role in various fields such as astronomy, geodesy, navigation, surveying, and many more.

The concept of distance measurement has been around for centuries, with early civilizations using primitive methods such as pacing, ropes, and sticks. However, with the advancements in technology, we now have access to sophisticated instruments that can measure distances with high precision and accuracy.

Today's the developing world shows various adventures in every field. In each field the small requirements are very essential to develop big calculations. By using different sources we can modify it as our requirements and implement in various field. In **earlier days the measurements are generally occur through measuring devices**. But now a day's digitalization as is on height. Therefore we use a proper display unit for measurement of distance. We can use sources such as sound waves which are known as ultrasonic waves using ultrasonic sensors and convert this sound wave for the measurement of various units such as distance, speed. This technique of distance measurement using ultrasonic in air includes

continuous pulse echo method, a burst of pulse is sent for transmission medium and is reflected by an object kept at specific distance. The time taken for the sound wave to propagate from transmitter to receiver is proportional to the distance of the object.

1.2 Global Scenario:

Distance measurement using Arduino and ultrasonic sensors are vast and diverse. They can be used in autonomous vehicles for obstacle detection and collision avoidance, in industrial settings for object detection and positioning, in healthcare for monitoring patient distances, and in home automation for smart lighting and security systems.

Moreover, this technology can also be used in agriculture for crop monitoring, in sports for measuring ball speed and trajectory, and in education for teaching basic principles of physics and electronic

The development of smart cars requires new sensors that are able to measure distances in the range of a few centimetres to a few meters. Parking aids, as well as intelligent suspensions and headlight leveling, are some examples of features that require a distance measurement to be performed with contactless sensors. Several different physical principles can be employed to measure the distance but price limits greatly restrict the actual choices.

1.3 Problem Statement:

This study aims to create a simple, effective and efficient ultrasonic distance measuring device

To be specific, these are the questions that the researchers seek to answer:

1. Is it possible to create an effective and efficient ultrasonic distance-measuring device with a relatively low budget?
2. How much distance can the ultrasonic distance measuring device achieve?
 - a. Is it comparable to any of the measuring devices that are widely available and used?

- b. Does it do a better job of taking measurements than the ones that already exist?
3. Can the device take measurements with minimal to no errors?
4. Is it not too complicated to adapt the device?

Motivation of the project:

- Our main moto is to reduce the blindspot accidents.
- Blind spots exist in a wide range of vehicles: aircraft, cars, buses, trucks, agricultural equipments, heavy equipments, boats, ships, trams, and trains.
- Blind spots may occur in the front of the driver when the A-pillar (also called the windshield pillar), side-view mirror, or interior rear-view mirror block a driver's view of the road.
- Behind the driver, cargo, headrests, and additional pillars may reduce visibility.
- Proper adjustment of mirrors and the use of other technical solutions can eliminate or alleviate vehicle blind spots.
- A no zone is one of several areas around a large truck, where the truck driver cannot see. Collisions frequently occur in no zones.
- A blind zone is one of several areas around heavier rolling stocks
- So, we decided to implement a project called distance measurement using ultrasonic sensor in vehicle application.

CHAPTER 2

2.1 Literature Survey:

The researchers wanted to create an ultrasonic distance measuring device because of the advantages it can have over the ones that are widely available today. As described by Zakari and Aliyu (2014), “The advent of EDM equipment has completely revolutionaries all surveying procedures and resulted in a change of emphasis and techniques, by reason of the fact that distance can now be measured quickly and accurately”. The researchers have examined that if

a reliable ultrasonic measuring device would be introduced in the market, a lot of fields involving the importance of distance measurement would benefit from it. According to Sharma and Abrol (2014), when measuring distance, there are two methods: contact and non-contact. The researchers will be using a non-contact method because the ultrasonic sensor to be used does not have to be in physical contact with the object to be measured. In order to do so, the sensor uses the propagation of ultrasonic sound waves. The ultrasonic sensor that will be used by the researchers is the HC-SRO4. The sensor has a transmitter that vibrates short, high-frequency sound pulses that reach a surface then bounce back to the receiver. This method of electronically measuring distance is known as the Pulse Method. According to Rüeger (2012), the way which the Pulse Method works is that, "A short, intensive signal is transmitted by an instrument. It travels to a target point and back and thus covers twice the distance. Measuring the so-called flight time between transmission and reception of the same pulse, the distance may be calculated. To expound on how the ultrasonic sensor works, the study of Mehta and Tiwari (2018) describes the major part of the sensor, the transducer. An ultrasonic sensor usually has the transducer to convert sound energy into electrical energy and

vice-versa. These sound waves are in the frequency range of 20000hz which is beyond the hearing range of humans therefore only the sensor can detect them. First, they identified that signal processing is easier because the speed of sound is slower than the speed of light in the presence of air. Second, the relatively short ultrasonic wavelengths allow for a "more highly accurate distance measurement", therefore measuring the distance from such objects does not affect the measurements. Finally, ultrasonic is not affected by the effects of light and airborne dusts, allowing it to perform measurements of distance in outdoor environments. To elaborate, another paper on the use of ultrasonic sensor with the inclusion of Arduino by Soni et al. (2017) explains the theory of sound waves. According to the authors, "Sound waves are defined as longitudinal pressure waves in the medium in which they are travelling. Subjects whose dimensions are larger than the wavelength of the impinging sound waves reflect them, the reflected waves are called the echo. If the speed of sound in the medium is known and the time taken for the sound waves to travel the distance from the source to the subject and back to the source is measured, the distance from the source to the subject can be computed accurately". A similar study on the use of ultrasonic sensor for distance measurement was also done by Ratan and Luthra (2015). They also applied the use of an ultrasonic sensor for distance measuring due to its versatility and applicability in so many fields. Their objective was to create a low cost simple device with acceptable accuracy. Although they have met the objective of the project,

the limitations they found on their project was the need to orient the device perpendicularly to the “plane of propagation of the ultrasonic waves .Another similar study of an ultrasonic sensor for distance measurement was also done by Abdullah (2015). They used an ultrasonic sensor (particularly the HC-SRO4) for their study, it is because they found out that this material is to be the “most reliable.

CHAPTER 3

PROJECT DESCRIPTION

3.1 EXISTING METHODOLOGY

Ultrasonic sensors are commonly used as affordable methods to measure distance in industry. However, the accuracy of their measurements is often low, especially when inexpensive sensors and reasonably low-priced equipment are used. In this article, a low-cost ultrasonic-sensor module which is used for threshold-detection techniques is examined. Several numerical techniques, such as the least square method (LSM), piecewise LSM, and the Vandermonde method were applied to the sensor data to increase the accuracy of the distance measurement. Eventually, the smart filter signal detection algorithm was applied to the sensor data and the results were compared. The smart- filter-signal-detection algorithm provides 0.4-millimeter accuracy. In order to achieve this accuracy, the environment temperature is taken into account.

3.2 PROPOSED METHODOLOGY

The distance measurement system will consist of the HC-SR04 ultrasonic sensor, Arduino board, and various output devices. The ultrasonic sensor will be mounted on the front of the vehicle, facing forward to detect any obstacles in its path. When an obstacle is detected, the sensor will send a signal to the Arduino board, which will then process the data and provide feedback to the driver through the output devices. The feedback may include visual cues such as LED lights or auditory cues such as warning sounds.

- To implement this project, we will need an Arduino board, ultrasonic sensors, jumper wires, and a power source. The ultrasonic sensors will be mounted on the front and back bumpers of the vehicle, and connected to the Arduino board through jumper wires. Once the hardware is set up, we will write a program code that controls the sensors and processes the distance the measurements. The program will use algorithms to calculate the distance between the vehicle and nearby objects, and display the results on a screen or through audio feedback. The use of ultrasonic sensors and Arduino boards in vehicle applications has a wide range of potential applications beyond just parking and collision avoidance.
- For example, it could be used in autonomous vehicles to provide real-time feedback on the surrounding environment and adjust the vehicle's direction accordingly.
- It could also be used in logistics and transportation applications to monitor the distance between vehicles in a convoy or track the position of goods being transported.
- With the increasing demand for smart transportation solutions, the use of ultrasonic sensors and Arduino boards is likely to become more widespread in the coming years.

3.3 BLOCK DIAGRAM :

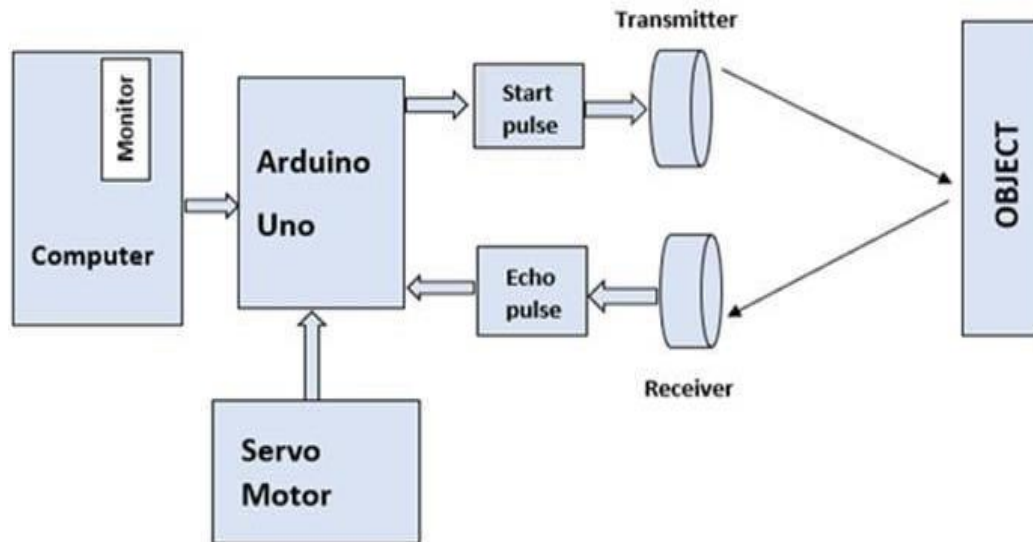


Fig:3.3.1

The ultrasonic sensors will be mounted on the front and back bumpers of the vehicle, and connected to the Arduino board through jumper wires..

Arduino will receive the data from the ultrasonic sensor and process it to calculate the distance between the vehicle and the obstacle. In addition to processing the data, the Arduino board will also be responsible for providing feedback to the driver through various output devices such as speakers or LED lights. In this project we have used buzzer to alert the driver.

CHAPTER 4

HARDWARE AND SIMULATION

4.1 COMPONENTS REQUIRED:

- Jumper wires
- Arduino UNO R3
- Ultrasonic sensor (HC-SR04)
- 16×2 LCD I2C Display
- Breadboard

4.1.1 JUMPER WIRE:

A jump wire (also known as jumper, jumper wire, DuPont wire) is an electrical wire, or group of them in a cable, with a connector or pin at each end (or sometimes without them – simply "tinned"), which is normally used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering.



Fig: 4.1.1

Arduino Uno is a microcontroller board based on the ATmega328P (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator (CSTCE16M0V53-R0), a USB connection, a power jack, an ICSP header and a reset button.

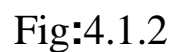


Fig:4.1.2

4.1.2.1 PIN DETAILS – ARDUINO UNO

IOREF (only in R3)	Input Output voltage reference pin, it is internally connected to 5V. Arduino Shields can read this pin to see the board is running at 3.3V or 5V. This allows it to select proper power source or enable input output voltage translators for proper working.
RESET	This pin can be used to RESET arduino. LOW voltage level at this pin resets arduino which is similar to pressing RESET button.
3.3V	3.3V Output
5V	5V Output
GND	Reference Ground
Vin	External Power Input. You may connect +ive of the battery to this pin and -ive of the battery to GND.
A0 – A5	Analog Voltage Input Pins
AREF	Analog Voltage Reference Input. By default analog to digital converter reference voltages are 0 and 5V. We can change the higher reference voltage 5V using AREF pin and analogReference() function.
0 – 13	Digital Input Output Pins
~	Indicated PWM Outputs
TX & RX	Transmit and Receive pins of UART.

4.1.2.2 TECHNICAL DETAILS – ARDUINO UNO

Microcontroller	ATmega328
Operating Voltage	5V
Clock Speed	16MHz
Input Voltage Range (On-Board Regulator)	6 – 20V
Recommended Input Voltage Range	7 – 12V
Digital Input Output Pins	14 (6 can provide PWM output)
Max. Current per IO pin	40mA
Max. Current for 3.3V pin	50mA
Analog Input Pins	6
Flash Program Memory	32KB (of which 0.5KB is used by bootloader)
SRAM	2KB
EEPROM Data Memory	1KB

4.1.3 ULTRASONIC SENSORS

Ultrasonic sensors are great tools to measure distance and detect objects without any actual contact with the physical world. It is used in several applications, like in measuring liquid level, checking proximity and even more popularly in automobiles to assist in self-parking or anti-collision systems.



Fig:4.1.3

In this project, we have used the HC-SR04 UltrasonicSensor with Arduino to determine the distance of an obstacle from the sensor. The basic principle of ultrasonic distance measurement is based on ECHO. When sound waves are transmitted in the environment then waves return back to the origin as ECHO after striking on the obstacle. So we only need to calculate the traveling time of both sounds means outgoing time and returning time to origin after striking on the obstacle.

The speed of the sound is known to us, after some calculation we can calculate the distance. We are going to use this same technique for this Arduino distance measurement project.

4.1.3.1. Ultrasonic Sensor Module:

There are many types of Arduino distance sensors, but in this project we have used the HC-SR04 to measure distance in range of 2cm-400cm with an accuracy of 3mm. The sensor module consists of an ultrasonic transmitter, receiver and control circuit. The working principle of ultrasonic sensor is as follows:

- ❖ High level signal is sent for 10us using Trigger.
- ❖ The module sends eight 40 KHz signals automatically, and then detects whether pulse is received or not.
- ❖ If the signal is received, then it is through high level. The time of high duration is the time gap between sending and receiving the signal.

$$\text{Distance} = (\text{Time} \times \text{Speed of Sound in Air (340 m/s)})/2$$

4.1.3.2 Timing Diagram:

The module works on the natural phenomenon of ECHO of sound. A pulse is sent for about 10us to trigger the module. After which the module automatically sends 8 cycles of 40 KHz ultrasound signal and checks its echo. The signal after striking with an obstacle returns back and is captured by the receiver. Thus the distance of the obstacle from the sensor is simply calculated by the formula given a

$$\text{Distance} = (\text{time} \times \text{speed})/2.$$

Here we have divided the product of speed and time by 2 because the time is the total time it took to reach the obstacle and return back. Thus the time to reach obstacle is just half the total time taken.

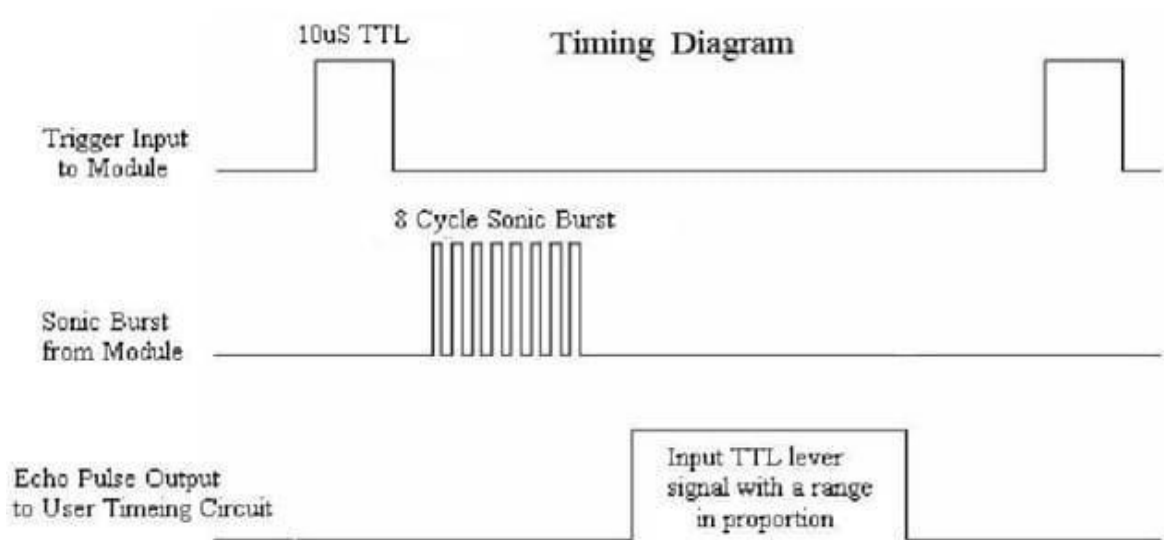


Fig:4.1.3.2

4.1.4 16X2 LCD DISPLAY

This is a 16x2 LCD display screen with I2C interface. It is able to display 16x2 characters on 2 lines, white characters on blue background. These displays are mainly preferred for multi-segment light-emitting diodes and seven segments. The main benefits of using this module are inexpensive; simply programmable, animations, and there are no limitations for displaying custom characters, special and even animations, etc.



Fig:4.1.4

Usually, Arduino LCD display projects will run out of pin resources easily, especially with Arduino Uno. And it is also very complicated with the wire soldering and connection. This I2C 16x2 Arduino LCD Screen is using an I2C communication interface. It means it only needs 4 pins for the LCD display: VCC, GND, SDA, SCL. It will save at least 4 digital/analog pins on Arduino. All connectors are standard XH2.54 (Breadboard type). You can connect with the jumper wire directly.

4.1.5 Breadboard

A breadboard is a solderless construction base used for developing an electronic circuit and wiring for projects with microcontroller boards like Arduino. As common as it seems, it may be daunting when first getting started with using one.

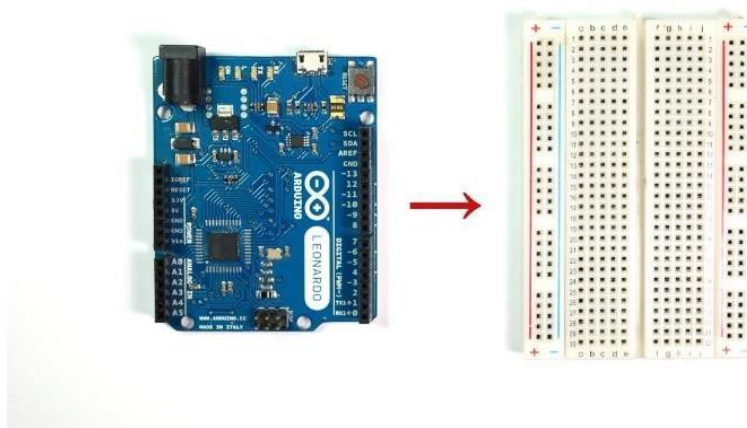


Fig:4.1.8

4.2 Simulation Output using Tinkercad software:

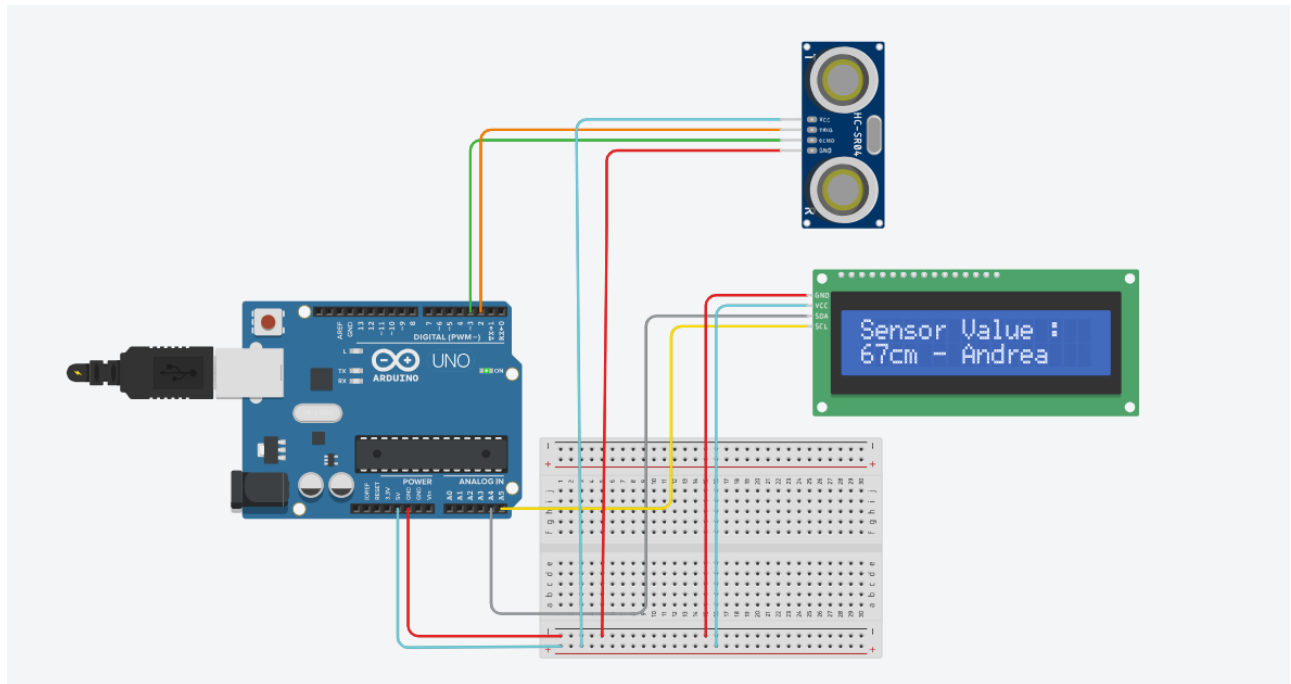


Fig:4.3 b

4.3 ARDUINO PROGRAM:

```
#include <Adafruit_LiquidCrystal.h>
#define trigPin 2
#define echoPin 3
long duration;
int distance;
Adafruit_LiquidCrystal lcd_1(0);
void setup() {
  pinMode(trigPin, OUTPUT);
  pinMode(echoPin, INPUT);
  Serial.begin(9600);
  lcd_1.begin(16,2);
  lcd_1.print("Sensor Value :");
}
void loop() {
  digitalWrite(trigPin, LOW);
  delayMicroseconds(5);
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);
  duration = pulseIn(echoPin, HIGH);
  distance = duration * 0.034 / 2;
  lcd_1.setCursor(0,1);
  lcd_1.print(distance);
  lcd_1.print("cm - Andrea");
  delay(50);
}
```

CHAPTER 5 CONCLUSION AND FUTURE SCOPE

Distance measurement using ultrasonic sensors and Arduino is a popular research area with various applications. The results of this review indicate that ultrasonic sensors and Arduino are widely used in the development of electronic projects related to distance measurement. Further research is needed to explore the potential of these technologies in various other applications

$$\text{Distance} = \text{speed} \times \text{time}$$

The human audible range can be converted measure the distance precisely manner

FUTURE SCOPE

The range can be improved by:

1. Using temperature adjustable devices, it can be used over wide temperature range.
2. Using High Range Ultrasonic sensors to extend the range of distance measurement.

References

- [1] .Arefin Shamsul MD., & Mollick Tajrian (2013). Design of an Ultrasonic Distance Meter. International Journal of Scientific & Engineering Research Volume 4, Issue 3
- [2].M. Rüeger, J. (1980). Recent developments in electronic distance measurement. Australia Surveyor30.10.1080/00050326.1980.10442489. [3]. Czajkowski, S. B. (1984). U.S. Patent No. 4,464,738. Washington, DC: U.S. Patent and Trademark Office.
- [4].Hils, T. (2010). U.S. Patent No. 7,643,927. Washington, DC: U.S. Patent and Trademark Office. Win, L. A., & Lam, W. C. W. (1988). U.S. Patent No. 4,730,190. Washington, DC: U.S. Patent and Trademark Office.
