PROJECT REPORT

ON

"DIY Height Measurement Tool with LCD"

THIS PROJECT & RESEARCH REPORT HAS BEEN INDEPENDENTLY DEVELOPED BY ME AND IS NOT SUBMITTED TO ANY COLLEGE OR UNIVERSITY FOR ACADEMIC EVALUATION

Developed by

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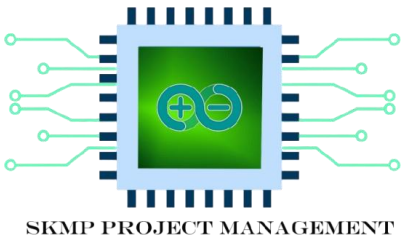

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DEPARTMENT OF IOT

POLISHLINE.BALASORE, ODISHA, INDIA

MAY -2026

“Dedicated to my beloved parents ,and teachers who have worked hard throughout my education”

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CERTIFICATE

This is to certify that the project entitled "DIY Height Measurement Tool with LCD"

Has been independently developed and completed by Suzen Kumar Mohanty for the purpose of enhancing technical knowledge, skills, and practical understanding.

This project is a self-initiated work carried out with person al interestand research. It has not been submitted to any college, university, or institution for the award of any degree or diploma.

The work presented in this project is genuine and has been completed by the developer himself.



Suzen Kumar Mohanty

(Project Developer)

Date: 24/05/2026

Place:-Balasore,Odisha,India

SELF ATTESTATION

I here by declare that I have personally worked on the project entitled "***DIY Height Measurement Tool with LCD***" All the data, analysis, and implementation presented in this project are the result of my own efforts and genuine work .Any external sources of information, if used, have been properly acknowledged.

This project is created solely for learning , skill development ,and professional improvement, and has not been submitted to any institution for academic purposes.



Suzen Kumar Mohanty

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Date: **24/05/2026**

Place:Balasore,Odisha,India

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DECLARATION

I hereby declare that the project titled "**DIY Height Measurement Tool with LCD**"is an original work carried out by me based on my own idea, research, and implementation.

This project that has not been submitted previously ,in part or in full, to any college, university, or institution for the award of any degree, diploma, or certification.

I confirm that all the information presented in this project is true to the best of my knowledge. Any references or sources used have been properly acknowledged.

I take full responsibility for the authenticity and originality of this work.

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Name: Mr. Suzen Kumar Mohanty

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Date:[**24/05/2026**]

ACKNOWLEDGMENTS

I would like to express my sincere gratitude to everyone who contributed, directly or indirectly, to the development of this project, "**DIY Height Measurement Tool with LCD**"

This project is the result of my personal interest, dedication, continuous learning, and exploration of electronics, automation, sensor technology, and control systems.

I am thankful to the developers of Arduino, the creators of open-source hardware and software resources, and the technical communities whose documentation, tutorials, and knowledge-sharing platforms helped me understand and implement the concepts used in this project.

I would also like to acknowledge the importance of self-learning, practical experimentation, and problem-solving throughout the development process. These experiences helped me strengthen my technical knowledge and improve my understanding of real-world automation systems.

Finally, I am grateful to everyone who supports innovation, DIY engineering, and independent technical projects. This work reflects my enthusiasm for learning, creating, and exploring new possibilities in technology.

Developed By:

Suzen Kumar Mohanty

ABOUT MYSELF



I am Mr. Suzen Kumar Mohanty , a passionate and dedicated Web Developer and SOC Analyst (Level 1) from the field of Computer Science and Engineering, with strong expertise in HTML, CSS, JavaScript, and I specialize in building scalable, responsive, and high-performance web applications that deliver seamless user experiences across all devices and screen sizes.

With a keen eye for detail, I focus on writing clean, maintainable, and well-structured code. My development approach is centered around Creating intuitive user interfaces, ensuring both functionality and aesthetic quality. I follow modern front-end development practices such as component-based architecture, responsive design principles, and performance optimization techniques to build efficient and user-friendly applications.

Beyond web development, I actively work on IoT-based solutions, where I integrate hardware and software to create smart, real-world systems. I have hands-on experience with Arduino Uno and various sensors, enabling me to develop projects such as environmental monitoring systems, smart automation solutions, and real-time data tracking applications.

One of my key strengths lies in connecting IoT devices with web technologies. I build interactive dashboards that allow real-time data visualization, giving users the ability to monitor, analyze, and control devices remotely. My work focuses on bridging the gap between the physical and digital world by transforming raw sensor data into meaningful insights.

I am deeply interested in developing innovative, data-driven solutions that combine web technologies with embedded systems. My goal is to create impactful applications that solve real-world problems while improving efficiency, automation, and user experience.

With a strong passion for continuous learning and innovation, I consistently explore new tools, frameworks, and technologies to enhance my skills and deliver high-quality, future-ready solutions.

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ABSTRACT

The **“DIY Height Measurement Tool with LCD Display and Arduino UNO”** is an innovative, low-cost electronic measurement system designed to measure a person's height automatically using ultrasonic sensing technology. The primary objective of this project is to develop a simple, efficient, and user-friendly device that reduces the need for manual height measurement using conventional measuring tapes or mechanical instruments. The system uses an **Arduino UNO microcontroller**, an **HC-SR04 ultrasonic sensor**, and a **16×2 LCD display with an I2C interface** to perform distance measurement and display the calculated height in real time.

The working principle of this project is based on ultrasonic wave transmission and reflection. The HC-SR04 sensor is mounted above the person's head and directed vertically downward. It transmits ultrasonic sound waves that travel towards the head and reflect back to the sensor. By measuring the time taken for the reflected waves to return, the Arduino UNO calculates the distance between the sensor and the person's head. The actual height is determined by subtracting this measured distance from the previously calibrated reference height between the floor and the sensor's acoustic reference plane.

The Arduino UNO processes the sensor readings using a programmed algorithm and applies basic filtering techniques to reduce fluctuations caused by measurement variations. The calculated height is then displayed on the 16×2 LCD, allowing

users to view their measurements immediately. The I2C communication interface simplifies the LCD connection by reducing the number of required data wires.

This project demonstrates the practical application of embedded systems, ultrasonic sensing, microcontroller programming, and real-time data processing. It provides an affordable and accessible platform for students, electronics enthusiasts, and beginners to understand the integration of hardware and software in an automated measurement system.

The proposed system can be further enhanced through the integration of Bluetooth, Wi-Fi, mobile applications, cloud-based data storage, voice announcements, and automatic user identification. Such improvements could expand its applications in educational institutions, laboratories, homes, and basic measurement environments.

Keywords: Arduino UNO, HC-SR04 Ultrasonic Sensor, Height Measurement, 16×2 LCD Display, I2C Communication, Embedded Systems, Distance Measurement, Automation, Real-Time Monitoring.

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1: INTRODUCTION

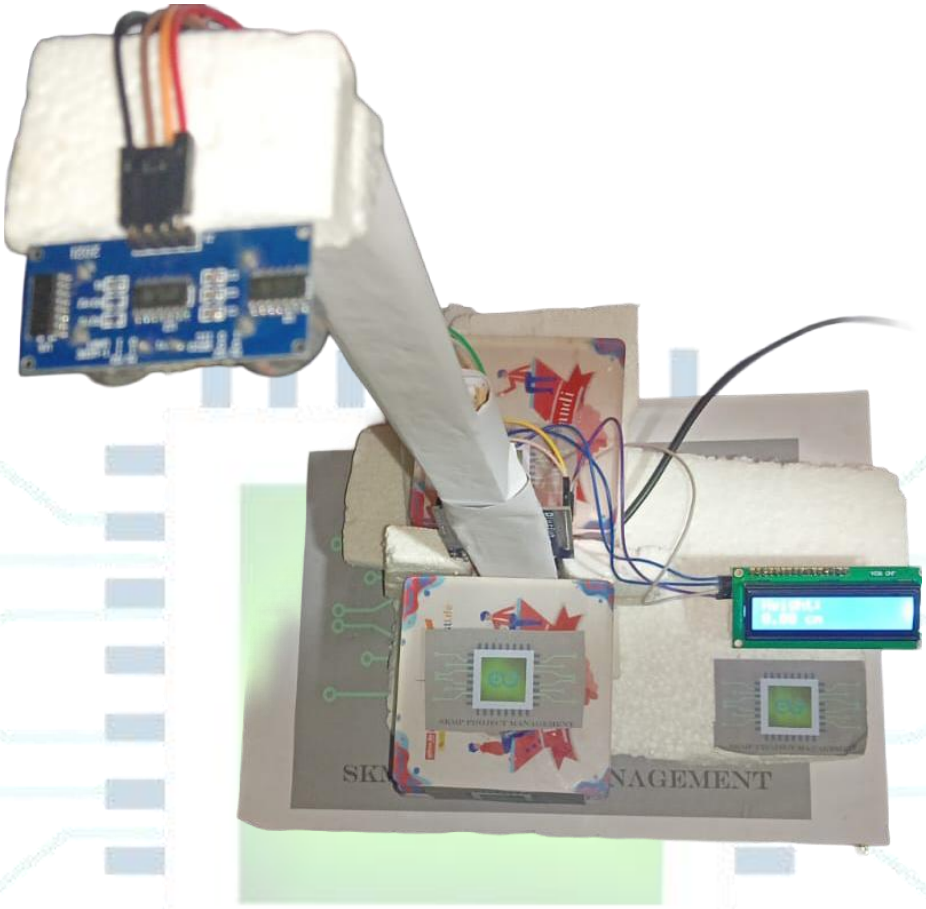

FIG-01

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1.1 Introduction to the Project

Height measurement is one of the most common forms of physical measurement. It is used in schools, hospitals, sports facilities, fitness centres, research laboratories and many other environments.

Traditionally, human height is measured using a measuring tape, wall scale or mechanical stadiometer. These methods require a person to stand in a proper position while another individual observes and records the measurement.

Although conventional techniques are widely used, they may involve several limitations:

- Manual reading can introduce human error.
- Measurements require physical interaction with the instrument.
- Incorrect positioning can affect the final result.
- Recording measurements manually takes additional time.
- Some low-cost measurement arrangements lack a clear digital display.

The advancement of embedded systems has made it possible to automate many measurement processes.

An Arduino-based height measurement tool is an example of this development. It uses an ultrasonic sensor to detect the distance between a fixed reference point and a target object.

The Arduino UNO processes the sensor's output and calculates the actual height using a mathematical formula. The final result is displayed on an LCD screen.

The project is designed to provide a practical demonstration of how electronic components can work together to perform a real-world measurement task.

1.2 Background of the Project

Ultrasonic technology is commonly used in distance measurement, object detection, obstacle avoidance, industrial automation and robotics.

An ultrasonic sensor operates by generating sound waves at frequencies higher than the normal human hearing range. These waves travel through the surrounding medium and reflect when they encounter an object.

The sensor detects the returning echo and calculates the distance based on the time taken by the sound wave to travel to the object and return.

This technique is called the **Time-of-Flight (ToF) measurement principle**.

The HC-SR04 is a commonly available ultrasonic ranging module. Its standard specifications describe a nominal measurement range of approximately 2 cm to 400 cm, with a claimed ranging accuracy that can reach 3 mm under suitable conditions. These are component specifications, not guaranteed accuracy for the complete height-measuring device.

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Arduino UNO acts as the central processing unit of the proposed system. It receives the echo timing information, converts it into distance and performs the height calculation.

1.3 Problem Statement

Traditional height measurement methods depend on manual observation and accurate positioning. These methods are simple, but they can produce inconsistent readings when the instrument is not aligned correctly or when the measurement is recorded incorrectly.

There is a need for a simple electronic demonstration system that can:

- Measure distance without physical contact.
- Calculate height automatically.

- Display the result digitally.
- Reduce manual reading and calculation.
- Be constructed using affordable and easily available components.

The proposed project addresses these requirements through the integration of an Arduino UNO and an ultrasonic sensor.

1.4 Aim of the Project

The primary aim is to design and develop a low-cost digital height measurement system using Arduino UNO, an HC-SR04 ultrasonic sensor and an LCD display.

The system aims to measure a person's approximate height by calculating the distance between a fixed reference point and the top of the person's head.

1.5 Objectives of the Project

The major objectives include:

1. To understand the working principle of ultrasonic distance measurement.
2. To interface an HC-SR04 sensor with Arduino UNO.
3. To develop a digital height calculation algorithm.
4. To interface a 16×2 LCD display with the Arduino board.
5. To display height readings in centimetres and metres.
6. To implement a stable and repeatable measurement process.
7. To understand sensor calibration and measurement errors.
8. To create a low-cost educational prototype.
9. To demonstrate real-time sensor data processing.
10. To provide a platform for future development using advanced sensors and wireless technologies.

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1.6 Scope of the Project

The scope of this project covers the design, development and demonstration of an electronic height measurement prototype.

The project includes:

- Ultrasonic distance sensing.
- Microcontroller-based data processing.
- LCD-based measurement display.
- Mechanical mounting of the sensor.
- Reference-height calibration.
- Basic error reduction using repeated measurements.
- Hardware testing and troubleshooting.

The project focuses on educational and general-purpose measurement demonstrations. It does not claim clinical accuracy or replace certified height-measuring equipment.

1.7 Significance of the Project

The significance of the project is its ability to demonstrate the practical use of embedded electronics in an everyday measurement application.

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It helps learners understand how sensors, microcontrollers and display devices interact to perform a complete automated task.

It also introduces important engineering concepts such as:

- Sensor interfacing.
- Signal timing.
- Mathematical computation.

- Real-time data processing.
- Hardware integration.
- Embedded programming.
- Calibration and accuracy evaluation.

1.8 Motivation Behind the Project

The motivation behind developing this system is to explore how a common measurement activity can be automated using affordable electronic components.

Arduino UNO provides a beginner-friendly platform for learning embedded programming, while ultrasonic sensors offer a practical way to measure distance without physical contact.

By combining these technologies, the project demonstrates that relatively simple electronic components can be used to create a useful prototype with opportunities for further innovation.

2: EXISTING SYSTEM AND PROPOSED SYSTEM

2.1 Existing Height Measurement Methods

Several conventional techniques are used for measuring human height.

A. Measuring Tape

A measuring tape is placed vertically against a wall. The person stands beside it, and the height is measured manually.

Limitations:

- Requires manual observation.
- May not remain perfectly vertical.
- Reading errors are possible.
- Requires correct positioning.

B. Wall-Mounted Height Scale

A graduated scale is fixed to a wall. The measurement is obtained by comparing the person's head position with the scale.

Limitations:

- Requires a flat vertical surface.
- Manual reading is required.
- Not easily portable.
- Alignment may affect results.

C. Mechanical Stadiometer

A stadiometer is a dedicated instrument used for measuring human height. It generally includes a vertical measuring column and a horizontal headpiece.

Limitations:

- Requires a properly assembled instrument.
- May be more expensive than a simple DIY prototype.
- Some models require manual reading.

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2.2 Proposed System

The proposed system uses ultrasonic technology to automate the height measurement process.

A sensor is installed at a fixed height above the floor. The sensor faces downwards and detects the distance to the upper surface of the person's head.

Arduino UNO receives the echo pulse from the sensor and calculates the distance. It then subtracts the measured distance from the fixed reference height.

The final measurement is displayed on the LCD.

2.3 Comparison Between Existing and Proposed Systems

Parameter	Conventional method	Proposed system
Measurement	Manual	Electronic
Sensing	Measuring scale	Ultrasonic sensor
Processing	Human observation	Arduino UNO
Display	Scale markings	LCD
Contact	Usually manual	Non-contact sensing
Calculation	Manual reading	Automatic
Power	Not required	Electrical supply
Cost	Varies by instrument	Low-cost prototype

2.4 Advantages of the Proposed System

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- Automatic height calculation.
- Contactless distance detection.
- Immediate digital display.
- Simple hardware architecture.
- Affordable components.
- Easy programming and modification.
- Useful for electronics education.

- Expandable for additional features.

2.5 Limitations of the Proposed System

- Ultrasonic measurements can fluctuate.
- The sensor requires correct vertical alignment.
- Irregular head surfaces can affect reflected echoes.
- Strong environmental interference may affect readings.
- The reference height must be calibrated.
- The device is not a certified clinical instrument.



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3: SYSTEM ARCHITECTURE

3.1 Overview of System Architecture

The complete system is divided into three major sections: input, processing and output.



FIG-2

Input Section

The HC-SR04 ultrasonic sensor acts as the input device. It measures the distance between the sensor and the target.

Processing Section

Arduino UNO receives the sensor output and performs the required calculations.

Output Section

The 16×2 LCD displays the calculated height.

3.2 System Operation

The system begins by initializing the Arduino UNO, sensor pins and LCD interface.

After initialization, Arduino sends a short trigger signal to the HC-SR04 sensor.

The sensor transmits ultrasonic pulses towards the person's head. When the waves encounter the target surface, they are reflected towards the receiver.

The sensor generates an echo pulse whose duration represents the round-trip travel time of the ultrasonic wave.

Arduino measures this pulse duration using the `pulseIn()` function.

The measured duration is converted into distance using the speed of sound. The distance is then subtracted from the calibrated reference height.

Finally, the calculated height is displayed on the LCD. The process repeats continuously to provide updated readings.

4: HARDWARE REQUIREMENTS

4.1 Complete Components List

Sl. No.	Component	Quantity	Purpose
1	Arduino UNO R3	1	Main controller
2	HC-SR04 ultrasonic sensor	1	Distance measurement
3	16×2 LCD display with I2C module	1	Display output
4	Breadboard	1	Temporary circuit assembly
5	Jumper wires	As required	Electrical connections
6	USB cable	1	Programming and power
7	5V regulated supply	1	Power supply
8	Vertical mounting frame	1	Sensor support
9	Measuring tape or ruler	1	Reference calibration
10	Screws and mounting brackets	As required	Mechanical assembly

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●Arduino UNO Board

- The Arduino UNO is an open-source microcontroller development board based on the ATmega328P microcontroller. It is widely used in electronics, robotics, automation, and embedded system projects. It allows users to connect various electronic components, such as sensors, LEDs, motors, displays, and other devices, to develop interactive electronic applications.
- The Arduino UNO board has 14 digital input/output pins, of which 6 can be used as PWM outputs, 6 analog input pins, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button.
- It can be programmed using the Arduino IDE with a simple programming language based on C and C++. The board receives instructions from the program and controls connected devices according to the given commands.

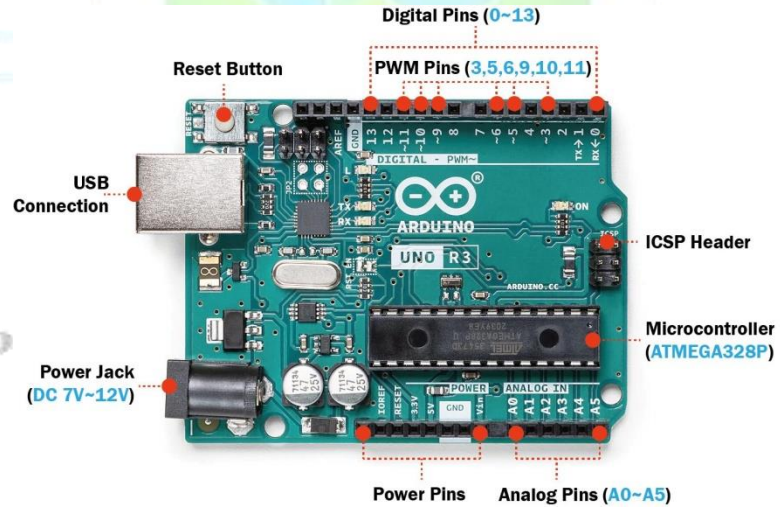

Fig -03

• *HC-SR04 Ultrasonic Sensor*

- The HC-SR04 Ultrasonic Sensor is an electronic distance-measuring sensor that uses ultrasonic sound waves to detect objects and measure the distance between the sensor and an object. It operates by transmitting high-frequency ultrasonic waves (approximately 40 kHz) and receiving the reflected waves (echo) from an object.
- The sensor consists of two main ultrasonic transducers: one acts as a transmitter (Trig), which sends ultrasonic waves, and the other acts as a receiver (Echo), which detects the reflected waves. The distance is calculated by measuring the time taken for the ultrasonic waves to travel to the object and return to the sensor.
- The HC-SR04 sensor is commonly used with microcontrollers such as Arduino UNO for distance measurement, obstacle detection, robotics, and automatic control systems.



Fig -04

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• . Resistor 220ohm

- A 220-ohm (220Ω) Resistor is a passive electronic component used to limit or control the flow of electric current in an electronic circuit. It provides a specific resistance of 220 ohms and helps protect sensitive electronic components from excessive current that may cause damage.

- In Arduino-based projects, a 220Ω resistor is commonly used to limit current flowing through LEDs and other electronic components. It helps maintain safe operating conditions and improves the reliability of the electronic circuit.
- The resistor works according to Ohm's Law, which describes the relationship between voltage, current, and resistance.

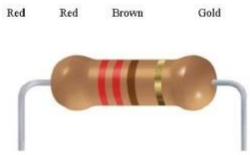

FIG-5

• Breadboard

- A Breadboard is a reusable electronic prototyping board used to build, test, and develop electronic circuits without soldering. It provides a convenient platform for connecting different electronic components using jumper wires.
- A breadboard contains several small holes arranged in rows and columns, which are internally connected through conductive metal clips. These connections allow electronic components such as resistors, LEDs, sensors, and microcontrollers to be connected easily.
- In Arduino-based projects, a breadboard is commonly used to connect components such as the Arduino UNO, HC-SR04 ultrasonic sensor, SG90

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servo motor, and resistors. It helps users assemble and modify circuits quickly during the testing and development process.

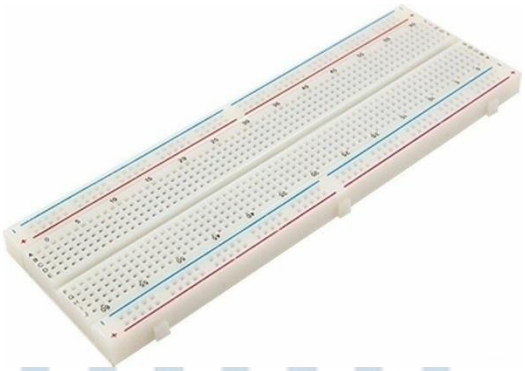

Fig-06

• Servo Motor (SG90)

- The SG90 Servo Motor is a small, lightweight, and compact rotary actuator used to control angular position with high precision. It is commonly used in robotics, automation, and Arduino-based electronic projects. The SG90 is a micro servo motor that can rotate approximately 180 degrees, allowing accurate control of its shaft position.
- The SG90 servo motor consists of a DC motor, a gear mechanism, a position feedback system, and an electronic control circuit. It operates based on Pulse Width Modulation (PWM) signals received from a microcontroller such as the Arduino UNO. By varying the width of the control pulse, the motor shaft can be positioned at a desired angle.
- The SG90 servo motor is widely used in projects requiring controlled movement, such as robotic arms, automatic doors, obstacle-avoiding robots, and digital measurement systems.

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Fig -07

• *Jumper Wires*

- Jumper Wires are electrical connecting wires used to establish temporary connections between different electronic components, sensors, and microcontroller boards. They are commonly used in electronics prototyping, Arduino projects, and embedded system development.
- Jumper wires are used to connect components such as Arduino UNO, ultrasonic sensors, servo motors, breadboards, LEDs, and other electronic modules without requiring soldering. They provide an easy and flexible method of transferring electrical power and signals between different components.
- Jumper wires are generally available in three types: Male-to-Male, Male-to-Female, and Female-to-Female. They are commonly insulated with different colours to help identify power supply, ground, and signal connections.



Fig -08

• *LED*

- An LED (Light Emitting Diode) is a semiconductor electronic component that produces light when an electric current flows through it in the forward direction. It is a type of diode that converts electrical energy into light energy through a process known as electroluminescence.
- LEDs are widely used in electronic circuits as visual indicators to display the operating status of a system. They are available in different colours, such as red, green, blue, yellow, and white.
- In Arduino-based projects, LEDs are commonly connected to digital output pins to indicate different operating conditions. The Arduino UNO controls the LED by switching it ON or OFF according to the programmed instructions.

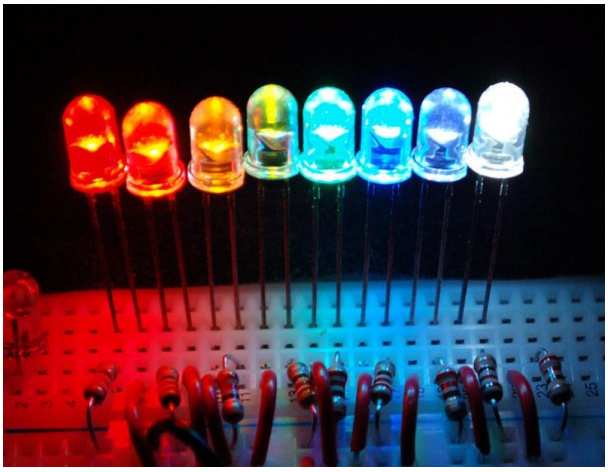

Fig-09

• *USB CABLE*

- A USB (Universal Serial Bus) Cable is an electrical communication cable used to establish a connection between electronic devices for data transmission and power supply. In Arduino-based projects, a USB cable is commonly used to connect the Arduino UNO board to a computer or laptop for programming, uploading code, and supplying electrical power.
- The USB cable allows communication between the computer and the Arduino UNO microcontroller. It transfers program instructions from the Arduino IDE to the board and also supports serial communication for monitoring sensor readings and debugging the project.
- The Arduino UNO R3 commonly uses a USB Type-B cable for connecting to a computer. One end of the cable connects to the Arduino board, while the other end connects to the computer's USB port.

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Fig -10

• *Power Supply (9V Battery with connector)*

- A 9V Battery with Connector is a portable DC power source used to provide electrical energy to electronic circuits and microcontroller-based projects. It consists of a 9V battery and a battery connector that allows easy connection to the power input terminals of an electronic circuit or Arduino UNO board.
- In Arduino-based projects, the 9V battery is commonly connected to the Arduino UNO through its DC barrel jack using a 9V battery snap connector with a suitable DC plug. It supplies electrical power to the microcontroller and connected electronic components when a computer or external power adapter is not available.
- The Arduino UNO has an onboard voltage regulator that converts the input voltage into a suitable operating voltage for the board. The 9V battery provides portability and makes the project suitable for standalone operation.

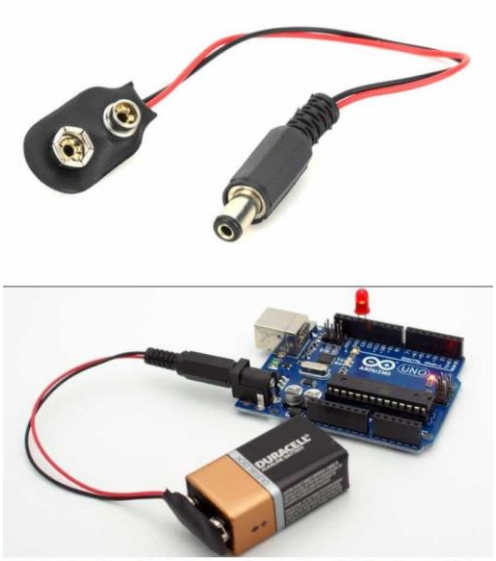

Fig -`11

• *RFID Card*

➢ An **RFID (Radio-Frequency Identification) card** is a contactless smart card that uses radio waves to transmit data between an embedded microchip and a reader device without requiring physical contact or a direct line of sight



Fig -`12

SKMP PROJE GEMENT

➢LCD

- A **16×2 LCD (Liquid Crystal Display)** is an electronic display module used to display text, numbers and measurement results in microcontroller-based projects. The term 16×2 indicates that the display contains 16 characters per row and has two rows, allowing a total of 32 characters to be displayed at a time.
- In the **DIY Height Measurement Tool with LCD Display and Arduino UNO**, the 16×2 LCD is used as the output device to display the measured height of a person in centimetres. It receives data from the Arduino UNO and presents the calculated measurement in a clear and readable format.
- The LCD can be connected to Arduino using an I2C interface module, which reduces the number of connecting wires and simplifies circuit design. Through this interface, Arduino sends commands and measurement data to the display.



FIG-13

5: CIRCUIT DESIGN AND CONNECTIONS

5.1 Circuit Design Overview

The circuit consists of three main electronic modules connected to Arduino UNO:

1. HC-SR04 ultrasonic sensor.
2. 16×2 LCD with I2C interface.
3. Power supply.

The ultrasonic sensor uses two digital pins for trigger and echo communication. The LCD uses two I2C communication pins.

5.2 HC-SR04 to Arduino UNO Connections

HC-SR04 Pin	Arduino UNO Pin
VCC	5V
GND	GND
TRIG	Digital Pin 9
ECHO	Digital Pin 10

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5.3 LCD I2C to Arduino UNO Connections

LCD I2C Pin	Arduino UNO Pin

VCC	5V
GND	GND
SDA	A4 / SDA
SCL	A5 / SCL

The I2C connection uses the UNO's SDA and SCL lines. On the UNO R3, these correspond to A4 and A5.

Arduino Official Store

5.4 Complete Connection Table

Component	Component Pin	Arduino Pin
HC-SR04	VCC	5V
HC-SR04	GND	GND
HC-SR04	TRIG	D9
HC-SR04	ECHO	D10
LCD I2C	VCC	5V
LCD I2C	GND	GND
LCD I2C	SDA	A4
LCD I2C	SCL	A5

5.5 Circuit Diagram Reference

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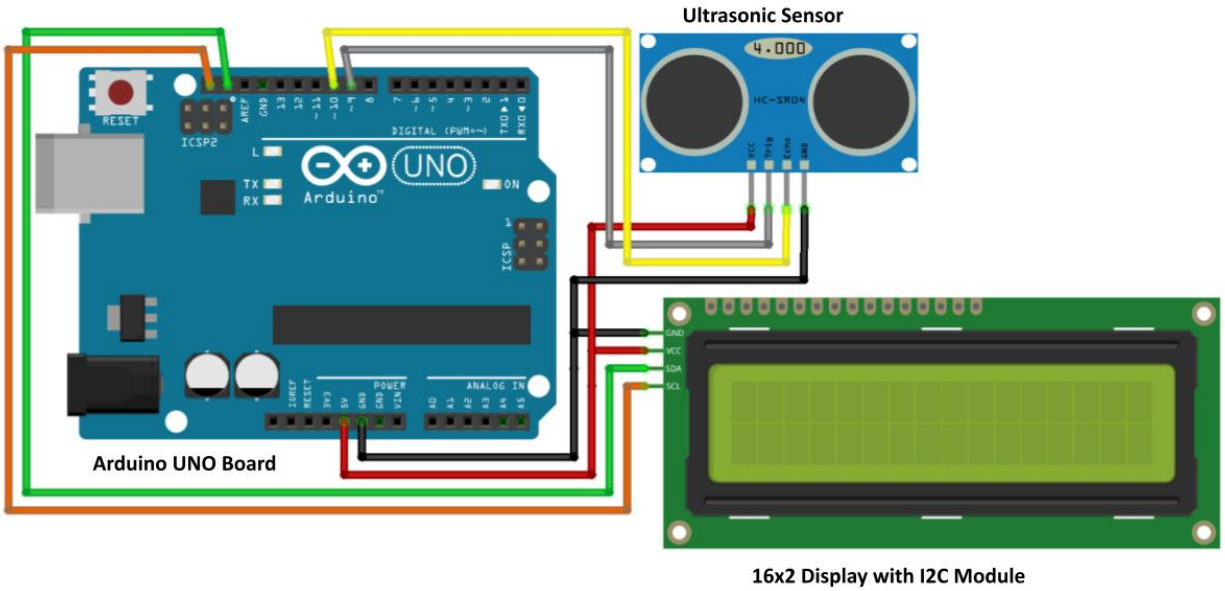

FIG-14

The diagram is intended as a visual wiring reference. Confirm the labels on the actual modules before connecting the power supply.

5.6 Important Circuit Precautions

- Check the polarity of all power connections.
- Ensure that all components share a common GND.
- Do not supply 9V directly to the HC-SR04.
- Check the I2C address of the LCD module.
- Avoid loose jumper connections.
- Secure the sensor before performing measurements.
- Disconnect the power before changing circuit wiring.

SIMA PROJECT MANAGEMENT

6: WORKING PRINCIPLE

6.1 Introduction

The working principle of the height measurement tool is based on ultrasonic time-of-flight measurement.

The sensor measures the distance between itself and a target. The Arduino uses this distance to calculate the height relative to the floor.

6.2 Ultrasonic Wave Generation

When the Arduino sends a trigger pulse of at least 10 microseconds, the HC-SR04 produces an ultrasonic burst of approximately 40kHz.

The waves travel through air towards the target.

6.3 Echo Detection

When the waves hit the upper surface of the person's head, a portion of the sound energy is reflected towards the receiver.

The Echo pin remains HIGH for a duration corresponding to the sound wave's round-trip travel time.

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6.4 Distance Calculation

The distance is calculated using the following formula:

\[D=\frac{T\times 0.0343}{2} \]

Where:

- D = Distance in centimetres.
- T = Echo duration in microseconds.
- 0.0343 = Approximate speed of sound in centimetres per microsecond at about 20°C.

Therefore:

$$ D=\frac{T}{58.3} $$

This is an approximate conversion. The speed of sound changes with air temperature and other environmental conditions.

6.5 Height Calculation

The most important part of the project is calculating the person's height.

The sensor is installed at a fixed vertical distance from the floor.

The height is calculated using:

$$ \boxed{H=R-D} $$

Where:

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- H = Person's height.
- R = Reference height from floor to sensor measurement plane.
- D = Distance from sensor to the top of the person's head.

Example calculation

Assume:

- Reference height = 220 cm.
- Measured distance = 50 cm.

Then:

\[H=220-50 \]
\[\boxed{H=170\text{ cm}} \]

The displayed height is therefore 170 cm.

6.6 Measurement Cycle

The system repeats the following operations:

1. Generate a trigger pulse.
2. Transmit ultrasonic waves.
3. Detect the returning echo.
4. Measure the echo duration.
5. Calculate the distance.
6. Calculate the height.
7. Display the result.
8. Repeat the process.

To avoid interference between consecutive measurements, the HC-SR04 documentation recommends an interval greater than approximately 60 milliseconds.

SIGUB PROJECT MANAGEMENT

7: SOFTWARE REQUIREMENTS AND PROGRAMMING

7.1 Software Requirements

The project requires software for programming the Arduino UNO and controlling the connected electronic components.

Software	Purpose
Arduino IDE	Writing and uploading code
Arduino C/C++	Embedded programming
LiquidCrystal_I2C library	LCD communication
Wire library	I2C communication
USB driver	Computer-to-board communication where needed

7.2 Introduction to Arduino IDE

Arduino IDE is a software development environment used to write, compile and upload programs to Arduino boards.

It provides an editor for writing code, a compiler for converting code into machine instructions and an upload facility for transferring the program to the microcontroller.

Official software and documentation are available from the Arduino Software page.



FIG-15

7.3 Programming Logic

The software follows a sequential process.

Step 1: Initialize the sensor pins.

Step 2: Initialize the LCD display.

Step 3: Send a trigger pulse.

Step 4: Read the echo duration.

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Step 5: Calculate distance.

Step 6: Subtract distance from reference height.

Step 7: Display the calculated result.

Step 8: Repeat the measurement.

7.4 Complete Arduino Source Code

The following code is designed for an Arduino UNO, HC-SR04 sensor and 16×2 LCD with an I2C adapter.

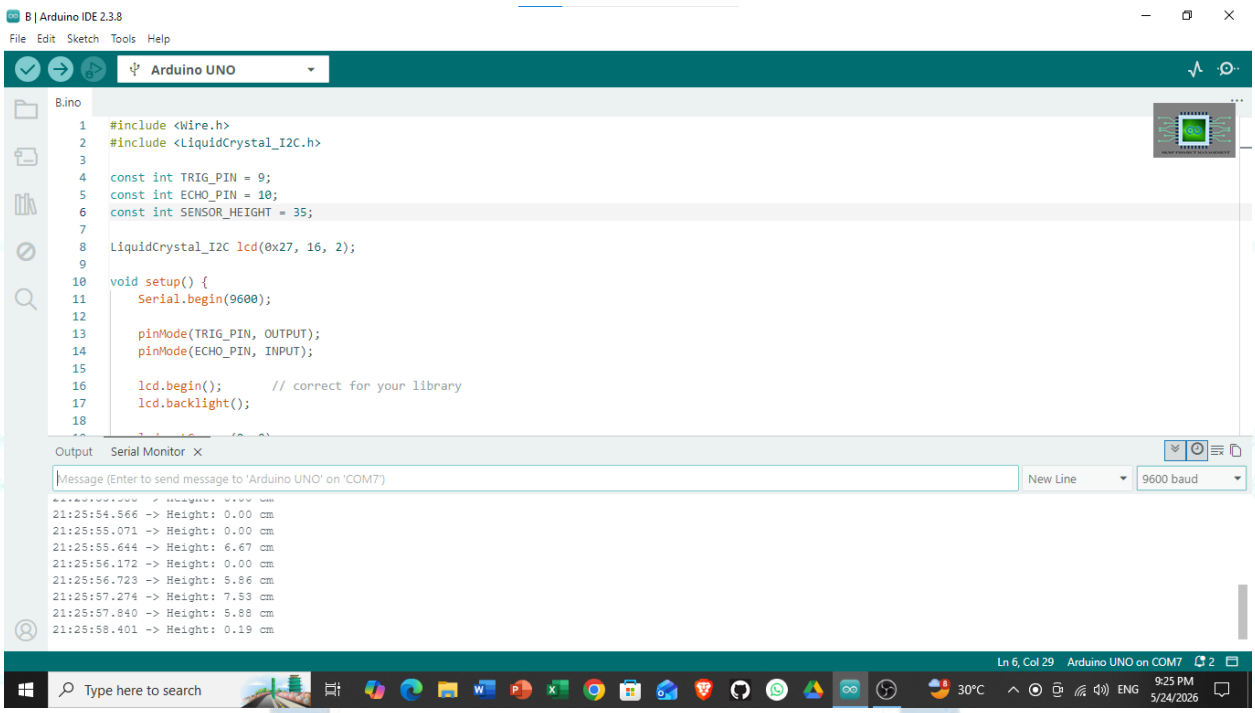

FIG-16

```
#include <Wire.h>
#include <LiquidCrystal_I2C.h>

const int TRIG_PIN = 9;  // Trigger Pin
const int ECHO_PIN = 10; // Echo Pin
const int SENSOR_HEIGHT = 30; // Height of sensor placement in cm

// Initialize the LCD (I2C address: 0x27, 16 columns, 2 rows)
LiquidCrystal_I2C lcd(0x27, 16, 2);

void setup() {
    Serial.begin(9600); // Start Serial Monitor

    pinMode(TRIG_PIN, OUTPUT); // Trig pin as OUTPUT
```

```
    pinMode(ECHO_PIN, INPUT);  // Echo pin as INPUT

    lcd.init();      // Initialize LCD
    lcd.backlight(); // Turn on backlight
    lcd.setCursor(0, 0);
    lcd.print("Height Meter");
    delay(2000);
}

void loop() {
    digitalWrite(TRIG_PIN, LOW);
    delayMicroseconds(2); // Ensure a clean pulse
    digitalWrite(TRIG_PIN, HIGH);
    delayMicroseconds(10); // Send ultrasonic pulse
    digitalWrite(TRIG_PIN, LOW);

    long duration = pulseIn(ECHO_PIN, HIGH);
    float distance = duration * 0.0343 / 2; // Convert to cm
    float height = SENSOR_HEIGHT - distance; // Calculate height

    Serial.print("Height: ");
    Serial.print(height);
    Serial.println(" cm");

    // Display on LCD
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("Height: ");
    lcd.print(height);
    lcd.print(" cm");

    delay(500);
}
```

7.5 Explanation of the Program

A. Library declaration

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`Wire.h` enables I2C communication, while `LiquidCrystal_I2C.h` is used to control the LCD module.

B. LCD initialization

The LCD is initialized with the address `0x27` and a display size of 16 columns and two rows. Some modules use `0x3F` instead, so the address must be checked.

C. Sensor pin configuration

Arduino digital pin 9 is used as the Trigger pin, and digital pin 10 is used as the Echo pin.

D. Reference height

The variable `referenceHeight` stores the vertical distance between the floor and the sensor's calibrated measurement plane.

The example uses 220 cm. This value must be changed to match the actual installation.

E. Distance measurement

The program sends a trigger pulse and reads the echo duration using `pulseIn()`.

F. Median filtering

Five readings are collected. Invalid readings are rejected, and the median of the valid measurements is used to reduce the influence of occasional outliers.

G. Height calculation

The program calculates the height by subtracting the measured distance from the reference height.

H. LCD output

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The LCD displays the calculated height and measured distance.

I. Serial monitoring

The Serial Monitor provides additional measurement information for debugging and testing.

7.6 Software Configuration

The following values should be checked before operation:

Configuration	Example value
LCD address	0x27
LCD dimensions	16×2
Trigger pin	D9
Echo pin	D10
Reference height	220 cm
Sample count	5
Echo timeout	30,000 µs
Measurement interval	70 ms between samples

The example height limits in the program are software filters and should be adjusted to the intended measurement range.

SRM PROJECT MANAGEMENT

8: HARDWARE ASSEMBLY AND IMPLEMENTATION

8.1 Introduction

Hardware assembly is an important stage in developing the height measurement tool. It involves connecting the electronic components, arranging the mechanical structure and verifying the electrical connections.

The assembly should be performed carefully to ensure that the system operates correctly and that the sensor remains stable during measurement.

8.2 Step-by-Step Hardware Assembly

Step 1: Prepare the components

Collect the Arduino UNO, HC-SR04 ultrasonic sensor, LCD display, breadboard, jumper wires, USB cable and mechanical mounting materials.

Check that all components are functioning and that their pins are correctly identified.

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Step 2: Connect the ultrasonic sensor

Connect the VCC pin to 5V, GND to GND, Trigger to digital pin 9 and Echo to digital pin 10.

Step 3: Connect the LCD display

Connect the I2C LCD's VCC and GND to the Arduino power connections. Connect SDA to A4 and SCL to A5.

Step 4: Prepare the mechanical frame

Construct a vertical frame using a suitable rigid material. The sensor should be installed at the upper end of the frame.

Step 5: Mount the ultrasonic sensor

Fix the sensor so that its two transducers face vertically downwards towards the measurement area.

Step 6: Fix the LCD display

Place the LCD at a convenient viewing position. The user should be able to read the height without changing their position.

Step 7: Check the wiring

Inspect every connection and verify that the supply voltage and common ground are correct.

Step 8: Upload the program

Upload the Arduino program and verify that the LCD initializes correctly.

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Step 9: Calibrate the system

Measure the distance from the floor to the sensor's acoustic reference plane. Enter this value into the program.

Step 10: Perform a measurement

Ask a person to stand directly below the sensor. The system should detect the distance from the sensor to the top of the head and display the calculated height.

8.3 Mechanical Design Considerations

The mechanical structure is just as important as the electronic circuit.

A suitable structure should provide:

- A rigid vertical support.
- A stable upper sensor mounting bracket.
- A flat and level standing surface.
- A clearly marked measurement position.
- A protected location for the Arduino and wiring.
- A convenient LCD viewing position.

The sensor should not move during operation. Even a small change in its position can alter the reference height.

8.4 Recommended Sensor Position

The sensor must face the top of the head and remain parallel to the vertical measurement axis.

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The person should stand directly underneath the sensor rather than at an angle.

The ultrasonic signal should reach the head without obstruction from hair accessories, hats or nearby objects.

9: CALIBRATION AND MEASUREMENT ACCURACY

9.1 Introduction to Calibration

Calibration is the process of adjusting a measurement system using a known reference.

In this project, calibration is essential because the system calculates human height using a fixed reference measurement.

If the reference height is incorrect, every displayed height will contain a corresponding offset error.

9.2 Reference Height Calibration

The reference height is the vertical distance from the floor's measurement surface to the sensor's acoustic reference plane.

It should be measured using a reliable measuring tape or ruler.

For example:

\[R=220\text{ cm} \]

The measured value is entered into the Arduino program:

```
const float referenceHeight = 220.0;
```

The actual value must be measured after the sensor has been mounted.

9.3 Calibration Procedure

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1. Install the sensor securely.
2. Ensure the standing platform is level.
3. Measure the distance from the floor to the sensor reference plane.
4. Record the measurement.
5. Enter the value into the Arduino code.
6. Use a known-height reference object or calibrated measuring instrument.
7. Compare the calculated reading with the reference.
8. Repeat the test several times.
9. If a consistent systematic offset remains, investigate the sensor geometry and mounting reference.
10. Recheck the calibration after changing the mechanical arrangement.

9.4 Measurement Accuracy Factors

The accuracy of the system depends on several factors.

A. Sensor Alignment

Incorrect sensor alignment can cause the sound waves to reflect away from the receiver.

B. Surface Reflection

The shape and surface characteristics of the target affect the quality of the reflected signal.

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C. Environmental Temperature

The speed of sound changes with air temperature. Therefore, a fixed conversion factor may introduce small measurement errors under different environmental conditions.

D. Sensor Mounting

If the sensor moves, the reference height changes.

E. Human Positioning

The person must stand directly beneath the sensor, with the head in the measurement area.

F. Hair and Head Accessories

Loose hair, caps and other accessories may affect the measured upper surface.

G. Ultrasonic Beam Width

The sensor does not detect only a mathematical point. It operates over an effective detection area, and nearby surfaces can produce unwanted echoes.

9.5 Methods to Improve Accuracy

- Use a rigid mounting structure.
- Keep the sensor vertically aligned.
- Measure the reference height carefully.
- Maintain a clear measurement area.
- Use repeated sensor readings.
- Apply median filtering to remove occasional outliers.
- Avoid measurements during excessive movement.
- Use temperature compensation if greater consistency is required.
- Compare readings against a reliable reference instrument.

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9.6 Understanding Sensor Accuracy Versus System Accuracy

An important engineering consideration is that the HC-SR04's claimed ranging accuracy does not automatically become the accuracy of the complete height measurement tool.

The final result also depends on:

- Reference-height measurement uncertainty.
- Sensor mounting alignment.
- Echo detection quality.
- Target geometry.
- Calibration errors.
- Environmental conditions.

Therefore, the final device should be evaluated as a complete system rather than relying solely on the sensor manufacturer's specification.

SKMP PROJECT MANAGEMENT

10: TESTING AND PERFORMANCE EVALUATION

10.1 Introduction

Testing is necessary to verify that the developed system performs the intended measurement process.

The testing procedure should examine the electronic connections, sensor response, LCD display, calculation accuracy and stability of repeated readings.

10.2 Hardware Testing

Hardware testing involves verifying the physical components individually.

Test	Procedure	Expected observation
Arduino test	Connect board through USB	Board powers on
Sensor test	Place an object in front	Echo is detected
LCD test	Power the LCD	Display initializes
Wiring test	Check connections	No loose connections
Power test	Check regulated supply	Stable operation
Complete system	Assemble all modules	Height is displayed

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10.3 Software Testing

Software testing checks the correctness of the program.

The following functions should be tested:

1. LCD initialization.

2. Trigger pulse generation.
3. Echo pulse measurement.
4. Distance calculation.
5. Height calculation.
6. Invalid echo handling.
7. Repeated measurement.
8. Display updating.

10.4 Functional Test Cases

Test ID	Test condition	Expected result
TC-01	Switch on the system	LCD initializes
TC-02	No target detected	Invalid measurement message
TC-03	Place target below sensor	Distance is calculated
TC-04	Change target position	Distance changes
TC-05	Change reference height	Calculated height changes
TC-06	Measure a fixed target repeatedly	Readings remain reasonably consistent
TC-07	Disconnect sensor	Invalid echo is handled
TC-08	Place person under sensor	Approximate height is displayed

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10.5 Sample Measurement Calculation Table

The following table provides illustrative calculations using a fixed reference height of 220 cm.

Illustrative values only. These are not actual experimental results.

Reference height Measured distance Calculated height

220 cm	50 cm	170 cm
220 cm	45 cm	175 cm
220 cm	40 cm	180 cm
220 cm	55 cm	165 cm
220 cm	60 cm	160 cm
220 cm	35 cm	185 cm

10.6 Actual Experimental Observation Sheet

The following table can be completed after assembling and testing the physical prototype.

Trial	Reference height	Sensor distance	LCD height
1	____ cm	____ cm	____ cm
2	____ cm	____ cm	____ cm
3	____ cm	____ cm	____ cm
4	____ cm	____ cm	____ cm
5	____ cm	____ cm	____ cm

10.7 Performance Evaluation Parameters

The complete system should be evaluated using the following parameters:

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- Measurement range.
- Repeatability.
- Response time.
- Display readability.
- Calibration stability.
- Sensitivity to positioning.
- Reliability of echo detection.

- Error compared with a reference instrument.

10.8 Repeatability Testing

Repeatability refers to the ability of a measuring instrument to produce similar readings when the same target is measured under the same conditions.

To evaluate repeatability:

1. Place a fixed flat target at a known position.
2. Record the first measurement.
3. Repeat the measurement at least ten times.
4. Calculate the average reading.
5. Calculate the variation between readings.
6. Compare the readings with the reference distance.

The mean measurement can be calculated as:

$$ \bar{x}=\frac{\sum_{i=1}^{n}x_i}{n} $$

The range of the readings is:

$$ \text{Range}=x_{\max}-x_{\min} $$

This process helps determine whether the sensor produces stable measurements.

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10.9 Expected System Performance

Under appropriate conditions, the system is expected to:

- Detect a target within the sensor's usable range.

- Calculate the corresponding distance.
- Convert the distance into an approximate height.
- Display the result on the LCD.
- Update the result repeatedly.
- Reject readings when a valid echo is not obtained.

Actual performance must be established through physical testing.

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11: LIVE DEMONSTRATION AND PRACTICAL OPERATION



Fig-17

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11.1 Introduction

The live demonstration is one of the most important parts of this project because it allows viewers to observe the complete operation of the device.

The demonstration should show how the ultrasonic sensor detects a person's head, how Arduino calculates the height and how the LCD displays the result.

11.2 Demonstration Setup

Before starting the demonstration:

- Place the device on a stable surface.
- Ensure the vertical mounting frame is secure.
- Confirm the reference height.
- Power on the Arduino.
- Check that the LCD is functioning.
- Verify that the sensor faces downwards.
- Clear the measurement area.

11.3 Live Demonstration Procedure

Step 1: Power ON

Switch on the Arduino UNO using the USB connection or suitable power supply.

Step 2: System Initialization

The LCD displays an initialization message.

Step 3: Position the Participant

Ask the participant to stand on the designated measurement surface.

Step 4: Sensor Detection

The HC-SR04 detects the upper surface of the person's head.

Step 5: Distance Measurement

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Arduino receives the echo signal and calculates the distance.

Step 6: Height Calculation

The system subtracts the measured distance from the reference height.

Step 7: LCD Display

The LCD presents the calculated height in centimetres.

Step 8: Repeat

The participant can change position, and the LCD updates the measurement.

11.4 Example Live Demonstration

Suppose the sensor is installed at a height of 220 cm.

The sensor detects the person's head at a distance of 52 cm.

The calculation is:

$$H=220-52$$
$$H=168\text{ cm}$$

The LCD should display:

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HEIGHT: 168.0 cm

DIST: 52.0 cm

Example demonstration output

11.5 Live Demonstration Script

The following explanation can be used during a science exhibition, technical presentation or public demonstration.

"The project presented here is a DIY Height Measurement Tool developed using Arduino UNO and ultrasonic sensor technology.

The main objective of this device is to measure a person's height without using a conventional measuring tape.

The system uses an HC-SR04 ultrasonic sensor installed at a fixed height above the ground. The sensor sends ultrasonic waves towards the person's head and detects the reflected waves.

The Arduino UNO calculates the distance by measuring the time taken by the ultrasonic signal to travel and return.

After obtaining the distance, the system subtracts it from the fixed reference height to calculate the person's approximate height.

Finally, the calculated result is displayed on the LCD screen.

This project demonstrates how microcontrollers and sensors can be combined to create an affordable and practical electronic measurement system."

11.6 Demonstration Safety

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- Use a stable mounting frame.
- Do not allow the sensor to fall onto the participant.
- Keep electrical wiring away from walking areas.
- Use a suitable low-voltage power supply.
- Ensure that the participant stands comfortably.
- Avoid using the device as a clinical diagnostic instrument.

12: APPLICATIONS AND REAL-WORLD USES

12.1 Educational Institutions

The system can be used in schools, colleges and technical training centres to demonstrate sensor technology, Arduino programming and automated measurement.

12.2 Science Exhibitions

The project is suitable for science fairs and engineering exhibitions because its operation can be demonstrated in real time.

12.3 Embedded Systems Learning

Students can use the project to understand the relationship between sensors, microcontrollers, software and digital output devices.

12.4 Fitness and Sports Demonstrations

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The device can demonstrate how electronic measurement can be integrated into basic fitness-related systems.

However, professional sports assessments require suitable validated equipment.

12.5 Research and Experimentation

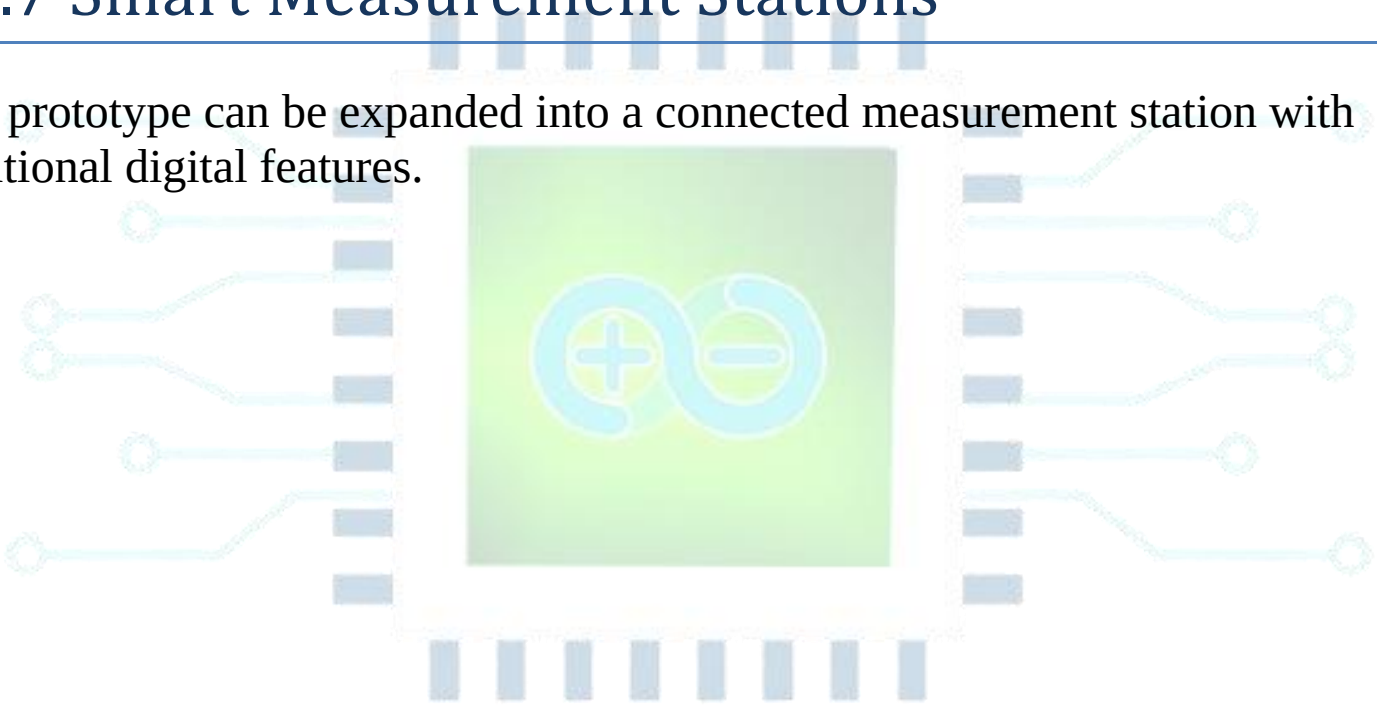
The project can act as a basic experimental platform for studying ultrasonic reflection, measurement repeatability, sensor calibration and error analysis.

12.6 DIY Electronics Development

Hobbyists and electronics enthusiasts can modify the system to develop more advanced digital measurement devices.

12.7 Smart Measurement Stations

The prototype can be expanded into a connected measurement station with additional digital features.



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13: ADVANTAGES, LIMITATIONS AND CHALLENGES

13.1 Advantages

1. Contactless measurement

The sensor detects the target without requiring direct physical contact.

2. Automatic calculation

Arduino calculates the height automatically.

3. Digital display

The LCD provides a direct and understandable measurement output.

4. Low-cost development

The project uses commonly available electronic components.

5. Simple construction

The circuit does not require complicated electronic components.

6. Educational value

It introduces practical concepts in electronics and programming.

7. Expandability

Additional components can be integrated to improve the functionality.

8. Real-time operation

The system can update measurements continuously.

13.2 Limitations

- The HC-SR04 has a limited measurement range.
- The device requires stable mounting.
- Target surfaces can affect echo detection.
- Incorrect alignment can cause measurement errors.
- Environmental conditions affect sound propagation.
- Multiple nearby objects can cause unwanted reflections.
- The basic version does not automatically save measurement history.
- The system is not suitable for certified clinical use.

13.3 Technical Challenges

Challenge	Possible solution
Fluctuating readings	Use median filtering
Incorrect height	Recalibrate reference height
No echo detected	Check alignment and wiring
LCD not displaying	Verify I2C address
Unstable sensor	Improve mounting frame
False reflection	Clear the measurement area
Power instability	Use regulated 5V supply
Measurement offset	Check the acoustic reference plane

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14: FUTURE SCOPE AND ENHANCEMENTS

14.1 Introduction

The current prototype provides a basic electronic height measurement facility. However, its architecture allows several improvements.

The project can be developed into a more advanced smart measurement system by integrating additional sensors, wireless communication, data storage and improved display technologies.

14.2 Integration of a High-Accuracy Distance Sensor

The HC-SR04 is suitable for educational demonstrations, but more advanced distance sensors can be explored for improved measurement performance.

Possible upgrades include:

- Time-of-flight laser distance sensors.
- Industrial ultrasonic sensors.
- Sensors with better repeatability.
- Sensors with narrower detection fields.

The selected sensor must be evaluated for its suitability, operating range, mounting geometry and safety.

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14.3 Bluetooth Connectivity

Bluetooth can be added to transmit the calculated height to a smartphone.

An application could display measurement readings and allow users to store or review previous measurements.

14.4 Wi-Fi Connectivity

A Wi-Fi-enabled microcontroller, such as ESP32, could be used to transmit measurement data to a web dashboard.

This could allow remote monitoring and centralized data collection.

14.5 Cloud-Based Data Storage

The system could be connected to a cloud database to store measurement records.

Possible stored information includes:

- Measurement ID.
- Date and time.
- Height.
- Device identification.
- Calibration status.

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If measurements are associated with individuals, privacy, consent and data security must be considered.

14.6 Voice Output

A voice module or audio playback device could announce the calculated height.

For example:

"Your measured height is 170 centimetres."

This would improve accessibility and reduce the need to read the LCD.

14.7 Touchscreen Interface

A touchscreen could replace the basic LCD and provide additional controls.

Possible functions include:

- Start measurement.
- Repeat measurement.
- Select units.
- View stored results.
- Display calibration information.

14.8 Automatic Measurement History

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The device could use an SD card or internal storage to save previous readings.

This would allow users to review historical measurements and compare changes over time.

14.9 Dual-Sensor Configuration

A more advanced design could use additional sensors to verify the measurement or detect incorrect positioning.

However, multiple ultrasonic sensors must be coordinated carefully to prevent interference between their transmitted signals.

14.10 Improved Mechanical Structure

The prototype could be redesigned using:

- A rigid aluminium frame.
- Adjustable sensor mounting.
- A stable standing platform.
- Protective electronic housing.
- Improved cable management.
- A clear user-positioning guide.

14.11 Automatic Temperature Compensation

An additional temperature sensor could be incorporated to estimate the speed of sound under the current environmental conditions.

This would allow the software to use a temperature-dependent sound-speed calculation instead of a fixed conversion factor.

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An approximate relationship for ordinary atmospheric conditions is:

$$ V\approx331.3+0.606T $$

Where:

- V = Speed of sound in metres per second.

- \(T\) = Air temperature in degrees Celsius.

This can improve distance calculation when temperature variation is significant, although it does not eliminate other measurement errors.

14.12 Advanced Version: Smart Height Measurement System

The future version could integrate all the proposed improvements into a single device.

The advanced system could include:

- High-performance distance sensor.
- ESP32 microcontroller.
- Touchscreen display.
- Bluetooth and Wi-Fi connectivity.
- Cloud-based data storage.
- Voice feedback.
- Automatic measurement history.
- Calibration monitoring.
- User-friendly software interface.

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This would transform the basic DIY prototype into a more advanced digital measurement platform.

CONCLUSION

The DIY Height Measurement Tool with LCD Display and Arduino UNO demonstrates the practical implementation of an electronic height measurement system using ultrasonic sensing technology.

The project combines an HC-SR04 ultrasonic sensor, Arduino UNO microcontroller and 16×2 LCD display to create a low-cost measurement prototype.

The system works by measuring the distance between a fixed reference point and the upper surface of a person's head. The ultrasonic sensor transmits sound waves and detects the reflected signal. Arduino UNO processes the echo duration, calculates the distance and determines the approximate height by subtracting the distance from the calibrated reference height.

The calculated measurement is then displayed on the LCD screen, allowing users to observe the result without performing manual calculations.

The project provides practical learning opportunities in embedded programming, ultrasonic sensing, digital communication, hardware interfacing, calibration and measurement analysis.

It also demonstrates how commonly available electronic components can be integrated to solve a real-world measurement problem.

Although the basic prototype has limitations relating to sensor alignment, echo reflection, environmental conditions and measurement accuracy, these challenges provide valuable opportunities for further engineering improvements.

Future developments could include wireless communication, cloud-based storage, advanced distance sensors, voice output, touchscreen interfaces and improved mechanical construction.

Overall, this project represents a useful educational and technical demonstration of contactless measurement using Arduino-based embedded systems.

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FUTURE SCOPE

The **DIY Height Measurement Tool with LCD Display and Arduino UNO** has significant potential for future development. The current prototype uses an HC-SR04 ultrasonic sensor to measure a person's height and displays the result on a 16×2 LCD. Although the system is suitable for educational purposes and basic demonstrations, several improvements can make it more accurate, user-friendly, automated, and suitable for wider applications.

The following enhancements can be considered in future versions of the project.

1. Integration of a More Accurate Sensor

The HC-SR04 ultrasonic sensor can be replaced with a more advanced distance-measuring sensor, such as a laser distance sensor or ToF (Time-of-Flight) sensor. These sensors can provide more stable measurements and potentially improve accuracy under suitable operating conditions.

2. Wireless Data Transmission

Bluetooth or Wi-Fi modules such as HC-05, ESP8266, or ESP32 can be integrated into the system. This would allow measured height values to be transmitted wirelessly to smartphones, computers, or other connected devices.

3. Mobile Application Integration

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A dedicated Android or web application can be developed to display measurement results. Users could view their height readings, maintain measurement records, and access previously recorded measurements.

4. Cloud-Based Data Storage

The system can be connected to cloud platforms such as Firebase or other IoT-based services. This would allow measurement records to be stored online and accessed from different locations.

5. Automatic User Identification

RFID cards, QR codes, or biometric identification systems could be integrated to identify individual users automatically. The system could then save each measurement under the corresponding user profile.

6. Voice Output Feature

A speaker or voice module can be added to announce the measured height. This feature would make the system more accessible and convenient for children, elderly individuals, and visually impaired users.

7. Data Logging and Historical Analysis

An SD card module or cloud database can be added to store measurement records with dates and timestamps. This would help users compare measurements over time and observe changes in recorded height.

8. Improved Display System

The existing 16×2 LCD can be upgraded to a larger LCD or OLED display. A graphical display could show measurement results, user information, previous readings, and system status more clearly.

9. Automatic Calibration System

An automatic calibration feature could be developed to reduce manual configuration. The system could guide the operator through setting the sensor reference height and checking measurement accuracy before use.

10. Multiple Measurement Modes

Future versions could include different operating modes, such as:

- Individual height measurement.
- Continuous measurement mode.
- Measurement history mode.
- Child and adult measurement profiles.
- School or institutional measurement mode.

11. IoT-Based Monitoring

By integrating an ESP32 or another IoT-enabled microcontroller, the system could become part of a smart monitoring environment. Authorized users could remotely view measurement records through an online dashboard.

12. Improved Mechanical Design

The prototype can be developed into a compact, portable, and professionally designed device. A sturdy vertical stand, adjustable sensor mounting, proper

alignment, and a stable measurement platform would improve usability and repeatability.

13. Multi-Language Support

The display and voice output can be upgraded to support multiple languages. This would make the device easier to operate in different regions and educational environments.

14. Enhanced Measurement Reliability

Future development can include improved filtering algorithms, repeated measurements, automatic error detection, and environmental testing. The system should also be tested against a calibrated reference measuring instrument to determine its actual accuracy and repeatability.

15. Integration with Educational and Healthcare Environments

The system could be adapted for use in schools, science laboratories, demonstration centres, and basic measurement stations. However, any healthcare application would require appropriate validation and should not treat the prototype as a medical-grade measuring instrument.

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REFERENCES

The following technical resources can be used to verify component specifications, understand the measurement principle and support further development.

1. Arduino Official Documentation

Arduino UNO Rev3 – Board specifications and hardware documentation.

Arduino UNO Rev3 Official Product Documentation.

2. HC-SR04 Ultrasonic Sensor Datasheet

Ultrasonic Ranging Module HC-SR04 – Technical specifications, timing principle and electrical connections.

HC-SR04 Technical Datasheet.

3. SparkFun Electronics

HC-SR04 Ultrasonic Distance Sensor – Product features and technical information.

SparkFun HC-SR04 Documentation.

4. SunFounder Technical Documentation

Ultrasonic Sensor Module – HC-SR04 operating principle and measurement method.

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SunFounder Ultrasonic Sensor Guide.

5. Arduino Software

Arduino IDE – Programming environment and development resources.

Arduino IDE Official Website.

6. Arduino Programming Reference

Arduino Language Reference.

7. Additional Technical Reading

- Embedded systems and microcontroller fundamentals.
- Ultrasonic time-of-flight measurement.
- Digital measurement and calibration principles.
- LCD interfacing using I2C communication.
- Basic electronic circuit design.

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PROJECT LINK

Website lnk:-https://skmp-project-management.vercel.app/

Google Drive Link:-
https://drive.google.com/drive/folders/1MTPd5lKATprVpp6JiyGGMmz9QQFIZRTB?usp=sharing

VideoLink:- https://youtu.be/TSOgYm0fKac?si=IXssuy-uWHwzxJ8j



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