Lab 4. Distance Measurement and Display

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1. Introduction

This project aims to create a system that measures and displays the distance between a sensor and an object placed in front of it. Using an ultrasonic sensor, the system will send out sound waves and calculate the time it takes for the waves to reflect off the object and return to the sensor. The distance is calculated based on the speed of sound and the measured delay time and will be shown on an attached LCD screen.

Objectives:

- To demonstrate the use of an ultrasonic sensor for distance measurement.
- To develop an efficient algorithm to calculate distance based on the echo time of the sound waves.
- To implement a system that displays the measured distance in real time on an LCD screen.
- To understand the operating principles of ultrasonic waves and their application in robotics.
- To develop practical skills in programming microcontrollers for sensor data processing.

2. Required Components

- **Arduino Uno R3**

A microcontroller board based on the ATmega328P. It features 14 digital input/output pins (6 of which can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller.

Electronic components used:

- **Breadboard**

A board used to connect electronic components such as wires, resistors, capacitors, and coils for experiments and projects.

- **LCD (Liquid Crystal Display)**

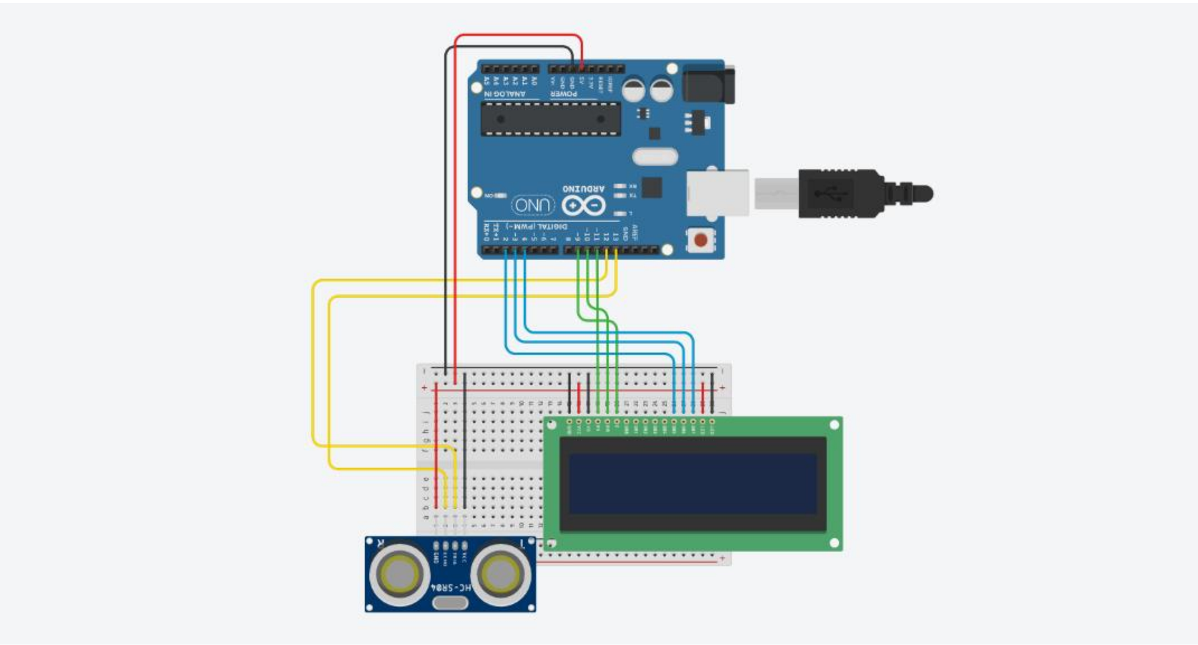
A flat-panel display that uses liquid crystals in its primary operation. LCDs are widely used in consumer and business devices such as smartphones, TVs, computer monitors, and instrument panels.

Sensor:

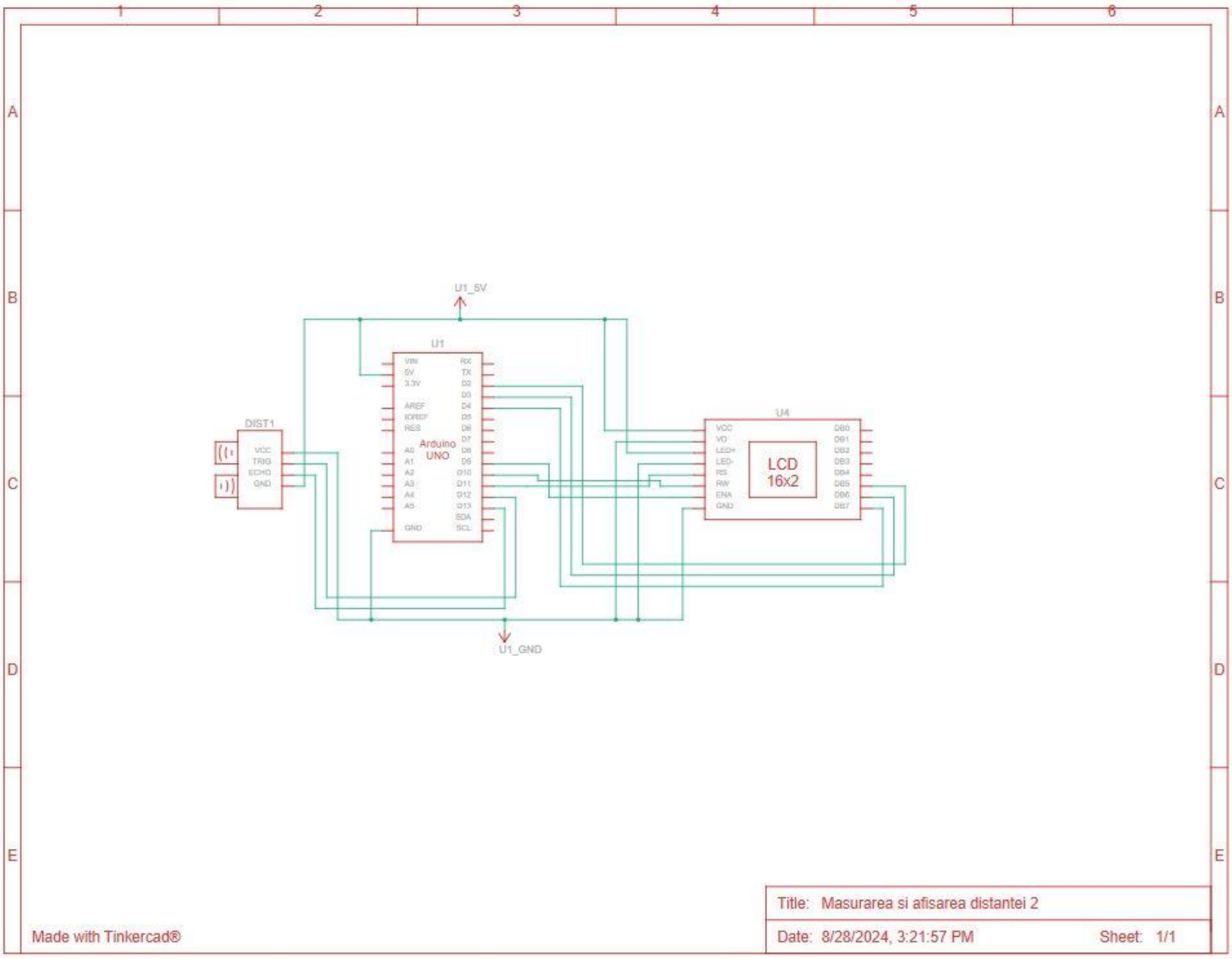
- **Ultrasonic Distance Sensor**

One of the most commonly used sensors for measuring distance. It emits ultrasound at a frequency of 40,000 Hz, which travels through the air, reflects off an obstacle, and returns to the sensor. Based on the speed of sound, the distance to the object can be calculated.

3. Circuit Diagram



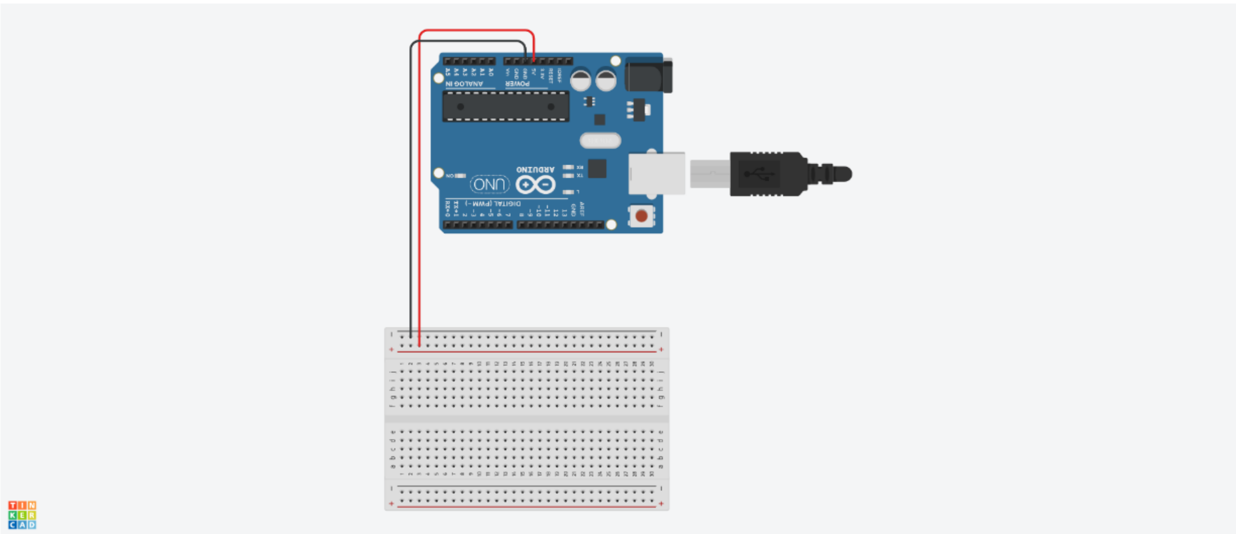
4. Wiring Diagram



5. Instructions

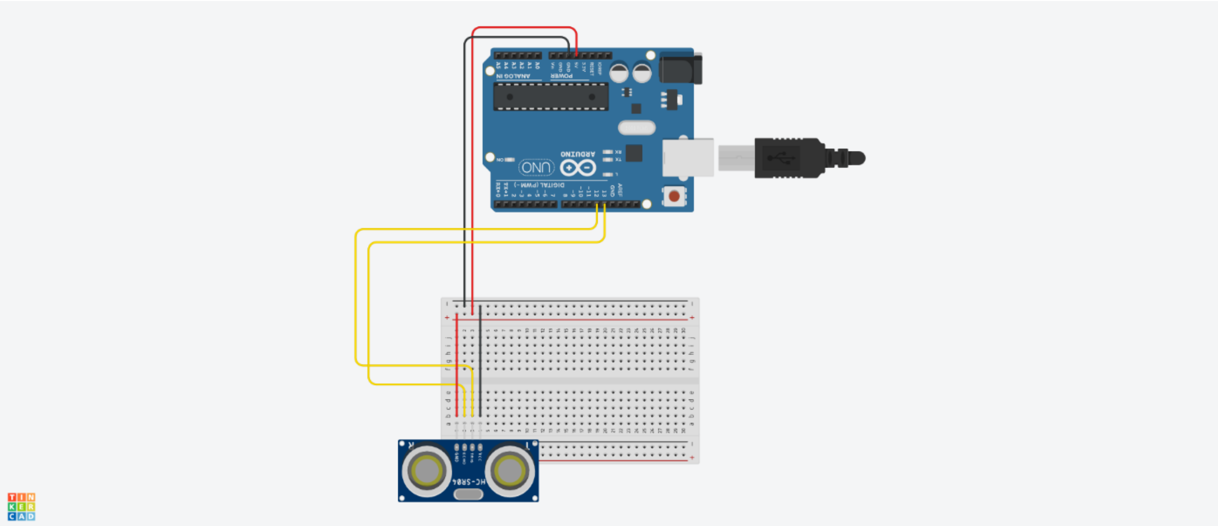
Power connections:

- Connect the Arduino's 5V pin to the power rail (+) of the breadboard.
- Connect the Arduino's GND (ground) pin to the ground rail (−) of the breadboard



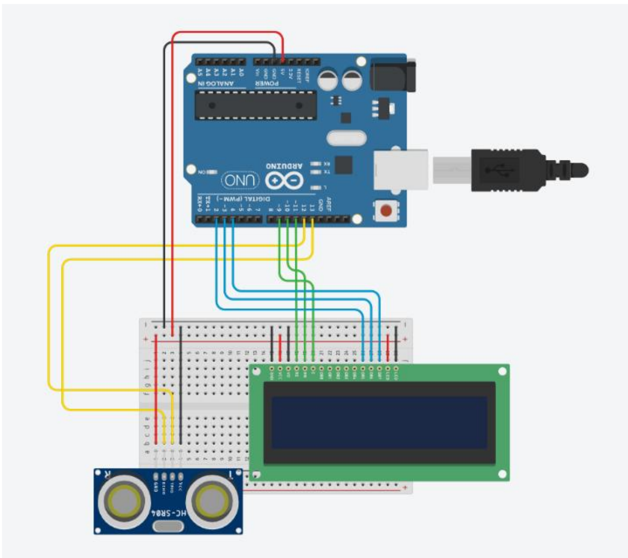
Connecting the HC-SR04 Ultrasonic Sensor to Arduino:

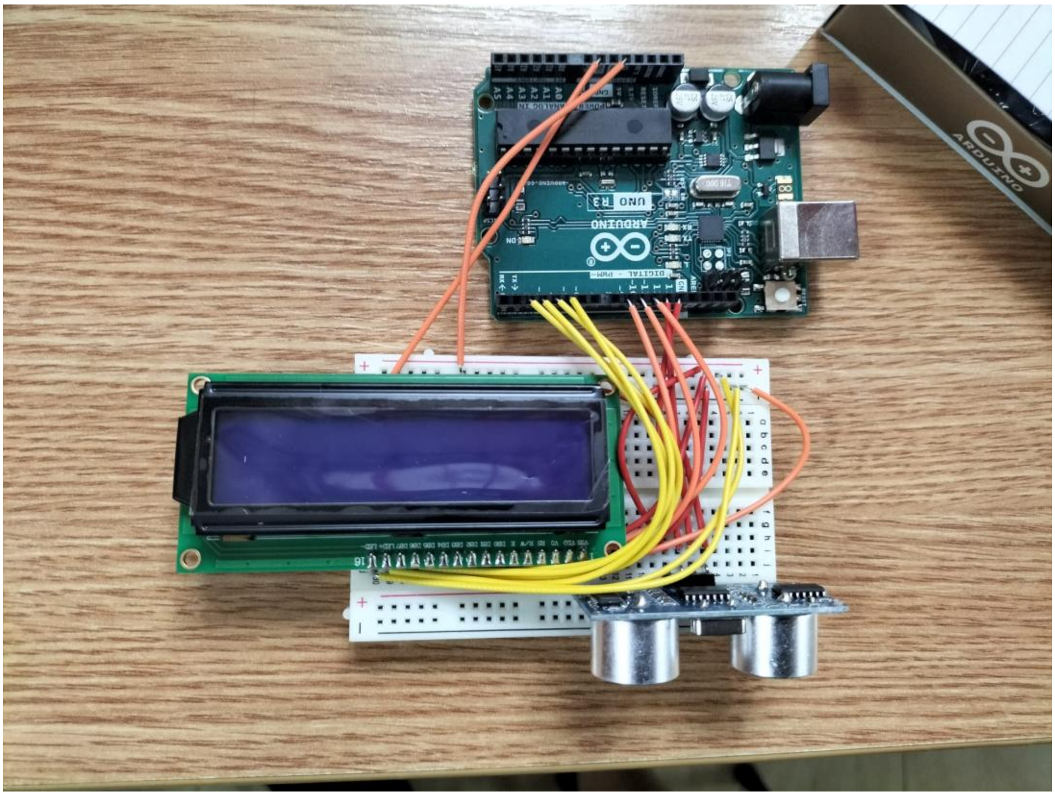
- Place the ultrasonic sensor on the breadboard
- VCC → 5V on the breadboard (connected to 5V on the Arduino)
- GND → GND on the breadboard (connected to GND on the Arduino)
- Trig → Digital pin 12 on the Arduino
- Echo → Digital pin 13 on the Arduino



Connecting the LCD to Arduino:

- Place the LCD on the breadboard
- VSS → GND on the breadboard (connected to Arduino GND)
- VDD/VCC → 5V on the breadboard (connected to Arduino 5V)
- VO → GND on the breadboard (connected to Arduino GND)
- RS → Digital pin 11 on the Arduino
- R/W → Digital pin 10 on the Arduino
- E → Digital pin 9 on the Arduino
- DB4 → Digital pin 2 on the Arduino
- DB5 → Digital pin 3 on the Arduino
- DB6 → Digital pin 4 on the Arduino
- DB7 → Digital pin 5 on the Arduino
- LED+ -> 5V on the breadboard (which is connected to 5V on the Arduino)
- LED- -> GND on the breadboard (which is connected to GND on the Arduino)





6. Programming

Software used: **Arduino IDE**

Code:

```
#include <LiquidCrystal.h>
LiquidCrystal LCD(11, 10, 9, 2, 3, 4, 5);
#define trigPin 13
#define echoPin 12

void setup()
{
  pinMode(trigPin, OUTPUT);
  pinMode(echoPin, INPUT);
  LCD.begin(16, 2);
  LCD.print("Target Distance:");
}

void loop()
{
  irit distanta, durata;
  digitalWrite(trigPin, LOW);
  delay(2);
  digitalWnite(trigPinj HIGH);
  delay(25);
  digitalWrite(trigPin, LOW);
  durata = pulseIn(echoPin, HIGH);
  distanta = (durata / 2) / 29.1;
```

```
  LCD.setCursor(0, 1);
  delay(25);
  LCD.print(” ”); //  Şterge  rândul  curent
  LCD.setCursor(0, 1);
  LCD.print(distanta);
  LCD.print(" cm");
}
```

7. Conclusions

This project demonstrates how we can create a simple distance measurement system using an ultrasonic sensor and an LCD screen, controlled by an Arduino Uno R3 board. Through this project, I learned how to connect electronic components to a breadboard, make the necessary connections to power and control both the sensor and LCD, and write a simple program to calculate and display the measured distance.

This project is an excellent example of the practical use of microcontrollers to interact with the surrounding environment and offers a solid foundation for developing more complex applications in robotics and automation.

8. References

Information:

- https://docs.arduino.cc/hardware/uno-rev3/
- https://www.sciencedirect.com/topics/engineering/breadboard
- https://www.techtarget.com/whatis/definition/LCD-liquid-crystal-display
- https://cleste.ro/senzor-ultrasonic-hc-sr04.html

Images:

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