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Distance sensing in an embedded system

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Abstract

The Arduino is an electronic board open -source for the development of many projects and concepts of automated control through an open-source language called Arduino c where is programmed by Arduino IDE. The purpose of this research is to develop a module to measure the distance for any body by using the concept of the ultrasonic waves (that mean using pulse velocity).

The ultrasonic ranging module HC - SRO4 is used as a distance sensor for detecting any move by measuring distance between sensor and body surface. The system consists of sensor Arduino Uno, LCD, LEDS variable resistance (it is very important to adjust the screen brightness (LCD)), Breadboard, and Wires. We adjust the distance on less than (10 cm) or to whatever value we want.

Anybody approaching from the ultrasonic sensor, the buzzer is turn on with the red led and the LCD is display the distance on the screen and this distance is measured in (cm), and if this body is stay away from this sensor (ultrasonic sensor) the buzzer is turn off and the green led is turn on.

Keywords: Arduino; LCD; Buzzer; Sensor; Embedded Systems

1. Introduction

The open-source electronics platform Arduino is built on user-friendly hardware and software.

Arduino boards can take inputs, like a tweet, a finger on a button, or a light on a sensor, and turn them into outputs, like turning on a motor, an LED, or publishing anything online. You may tell the microcontroller on your board what to do by giving it a set of instructions. This is done using the Arduino software (IDE) is based on Processing, whereas the Arduino programming language is based on Wiring. Arduino has been the brains behind millions of projects over the years, ranging from simple household items to intricate scientific apparatus.

This open-source platform has attracted a global community of professionals, makers, students, hobbyists, artists, and programmers. Through their efforts, an amazing amount of easily accessible knowledge has been accumulated that might be very beneficial to both beginners and specialists. At the Vireo Interaction Design Institute, Arduino was created as a simple tool for quick prototyping that could be used by students without any prior knowledge of electronics or programming. From simple 8-bit boards to wearables, 3D printing, embedded systems, and other applications, the Arduino board started to change to meet new needs and challenges as soon as it became publicly accessible.

Every Arduino board is completely open-source, allowing users to build them themselves and then alter them to meet their own needs. Furthermore, the application is open-source and keeps growing as a result of contributions from people worldwide.

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2. Problem statement

As HC-SRO4 sensors distance measurement systems cannot work in water and also cannot work good in large distance (equal or greater than 4 meter).

3. The objective

The main objective of this project is provide a useful system to measure the distance (using ultrasonic sensor with led and led screen) which will be easy to handle and configure, and to display how far the object is from the ultrasonic sensor by using speed of sound 340 m/s, and convert it to cm/us is become 0.034, the final distance is equal to s= (0.034 * t)/2.

4. The component

4.1. Arduino Uno using in an embedded systems:-

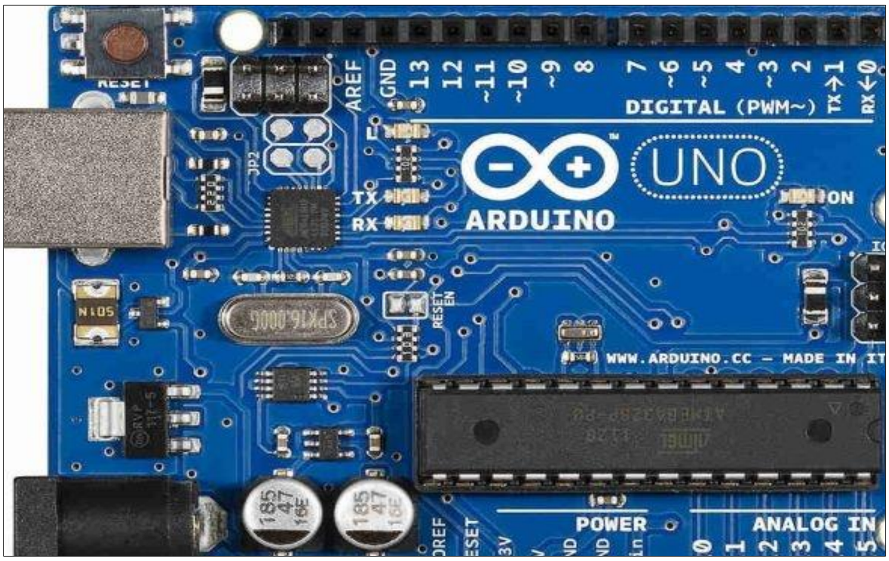

Figure 1 Arduino Uno R3 With digit pin

An 8-bit ATmega328P microcontroller serves as the foundation for the Arduino Uno. Together with the ATmega328P, it includes other parts to assist the microcontroller, including a voltage regulator, serial communication, and crystal oscillator.

Six of the Arduino Uno's 14 digital 1/O pins can be utilized as PWM outputs. It also has six analog input pins, a barrel power socket, an ICSP header, a reset button, and a USB port. Digital input/output pins can be used as input or output pins in Arduino programming thanks to the 14 pin Mode (), digital Read (), and digital Write () functions. Each pin has an inbuilt pull resistor of up to 20–50 kWh, operates at 5 volts, and may deliver or receive up to 40 mA at a time.

4.1.1. Arduino Uno to ATmega328 Pin Mapping

The figure below illustrates the pin configuration between an Arduino Uno and an ATmega328 chip, or vice versa.

Microcontroller	ATmega328P - 8 bit AVR family microcontroller

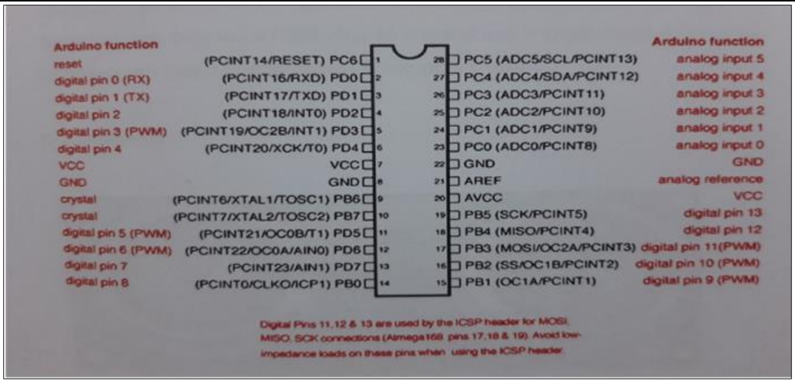

Figure 2 ATmega328 Pin Mapping

5. Communication

Allow Arduino to connect to other microcontrollers, a computer, or another Arduino panel (board). Pins 0 (Rx) and 1 (TX) can be used for serial communication using the ATmega328P controller's UART (TTL)(5V). The board's ATmegal6U2 communicates to this serial connection through USB and shows up as a virtual com port in the computer's software. There is no need for an external driver because the ATmegal6U2 firmware uses standard USB COM drivers. On Windows, though, a.inf file is necessary. Arduino provides a serial device that allows you to communicate simple text data to and from the Arduino board .

There are two RX and TX lights on the Arduino panel which will blink when delivering data via a USB chip to a serial and a USB connections to the computer not serial connections on the pins 0 and 1.

5.1. Ultrasonic

Figure 3 Ultrasound In Embedded system

Acoustic (sound) energy in the form of waves with a frequency higher than what humans can hear is known as ultrasound.

The maximum frequency that the human ear can pick up is around 20,000 Hz, or 20,000 cycles per second.

This is the boundary between the sonic and ultrasonic ranges. Applications for ultrasound include industrial, security, navigation, and electronics.

Viewing the body's interior organs is another use for it in medicine.

Due to their short wavelength, high-frequency acoustic waves reflect off of objects, even those that are very small. The delay between the velocity of an ultrasonic pulse being transmitted and the echo's return can be used to calculate the distance to an object. This is the well-known way that bats move through the dark. It is also thought that cetaceans, like whales and dolphins, use it underwater.

Sonar systems can use ultrasound to locate submarines, spot schools of fish, detect the presence of SCUBA divers, and measure the depth of the water in a certain area. A constant in an ultrasonic intrusion detection system,

The protected area is inundated with ultrasonic vibrations. Receiving transducers track the ultrasonic waves that are reflected off of items within the protected area. A shift in motion causes some of the reflected waves to change phase. Sensitive electrical circuits pick up this phase shift and relay the information to a dispatch center or alarm.

5.2. LCD (Liquid Crystal Display)

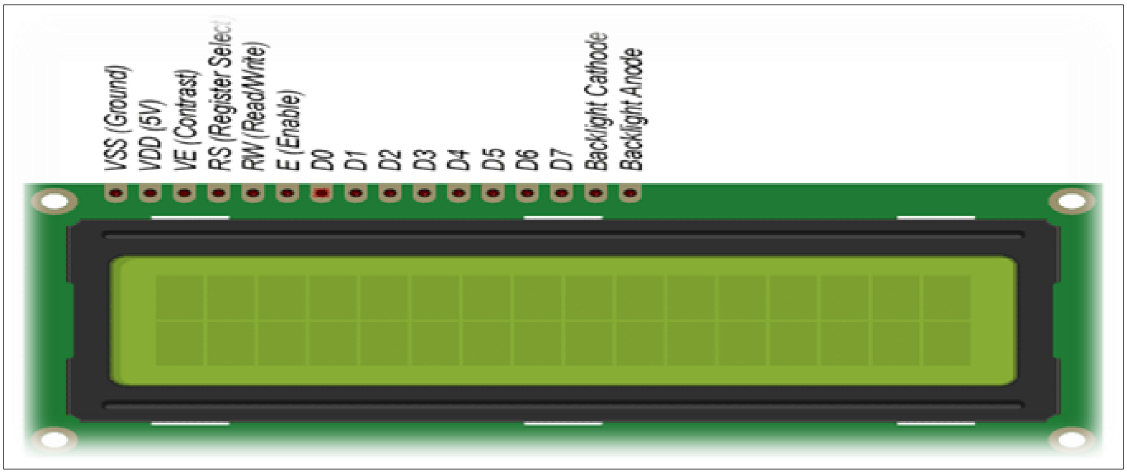

Figure 4 Liquid Crystal Display

Because the LCDS have a parallel interface, controlling the display requires the microcontroller to manage many interface pins simultaneously.

The following pins make up the interface:

The position of data writing to the LCD's memory is managed by a register select (RS) pin. The LCD controller can pick between the data register, which stores what shows on the screen, and the instruction register, which is where it looks for instructions on what to do next. Toggling between writing and reading modes is possible with a Read/Write (R/W) pin. Writing to the register's eight data pins (DO–D7) is made possible by an Enable pin.

The bits or values being written when you read are the states of these pins, which can be either high or low, when you write to a register. Furthermore, you may turn on and off the LED lighting, change the display contrast, and power the LCD using the display constrast pin (Vo), power supply pins (+5V and Gnd), and LED Backlight pins (Bklt+ and BKlt-). You must first enter instructions in the instruction register and then the data that constitutes the desired image in the data registers in order to operate the display. This is made simple for you by the Liquid Crystal Library, which eliminates the need for you to understand the intricate details.

5.3. Buzzer

An electronic gadget that is frequently used to create sound is the piezo buzzer. The inverse principle of piezoelectricity, which was established by Jacques and Pierre Curie in 1880, provides the basis for the piezo buzzer. It is the process by which mechanical pressure causes some materials to generate electricity and vice versa. We refer to these materials as piezoelectric materials. They produce sound when exposed to an alternating electric field because they compress or stretch according on the signal's frequency.

And connected the short party with ground and long party with any digital pin in Arduino we selected it previously.

5.4. Variable Resistance (or Potentiometer)

Figure 5 Potentiometer

6. Simulation & result

The code using in simulation is : -

The first thing you do is start the Arduino software (IDE) and enter the code below:-

```
#include <LiquidCrystal.h >

#include <NewPing.h >

LiquidCrystal lcd (12, 11, 5, 4, 3, 2);

int echoPin =7;

int trigPin =6;

int Led_ Red =10;

int Led_ Green =9;

int Buzzer =8;

Void setup () {

Serial.begin (9600);

pin Mode(trigPin,OUTPUT

pin Mode(echoPin,INPUT

pin Mode(Led_Red,OUTPUT

Pin Mode (Led Green, OUTPUT) ;

Pin Mode (Buzzer, OUTPUT);

lcd.begin (16, 2);

}

Void loop () {

Long duration;
```

```
Long distance;
digital Write(trigPin,LOW);              delay(15);
digital Write(trigPin,HIGH);
delay(10);
digital Write(trigPin,LOW);
duration=pulse ln(echoPin, HIGH);
distance=duration*0.034/2;
Serial. Print (distance);
Serial.println ("cm");
lcd. print("distance: ");
Icd print(distance);
lcd.print(" cm");
if (distance < 10) {        digital Write(Led_Red,HIGH);
digital Write(Buzzer, HIGH);
digital Write(Led Green,LOW);
} else{                              digital Write(Led_Red,LOW);
digitalWrite(Buzzer,LOW);
digital Write(Led_Green,HIGH);
}
delay(250);
Icd.clear();
}
```

Then we verify this code and upload it to the Arduino board.

7. Results

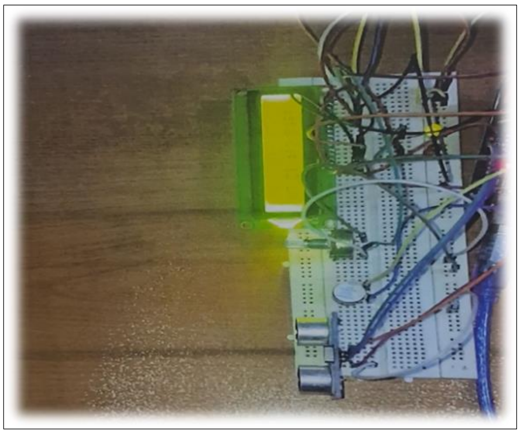

Figure 6 The connection device with Motherboard

This type of ultrasonic HC-SRO4 has a range to 4 meter and actually gives a reading accuracy to 3 meter.

8. The circuit of the Arduino

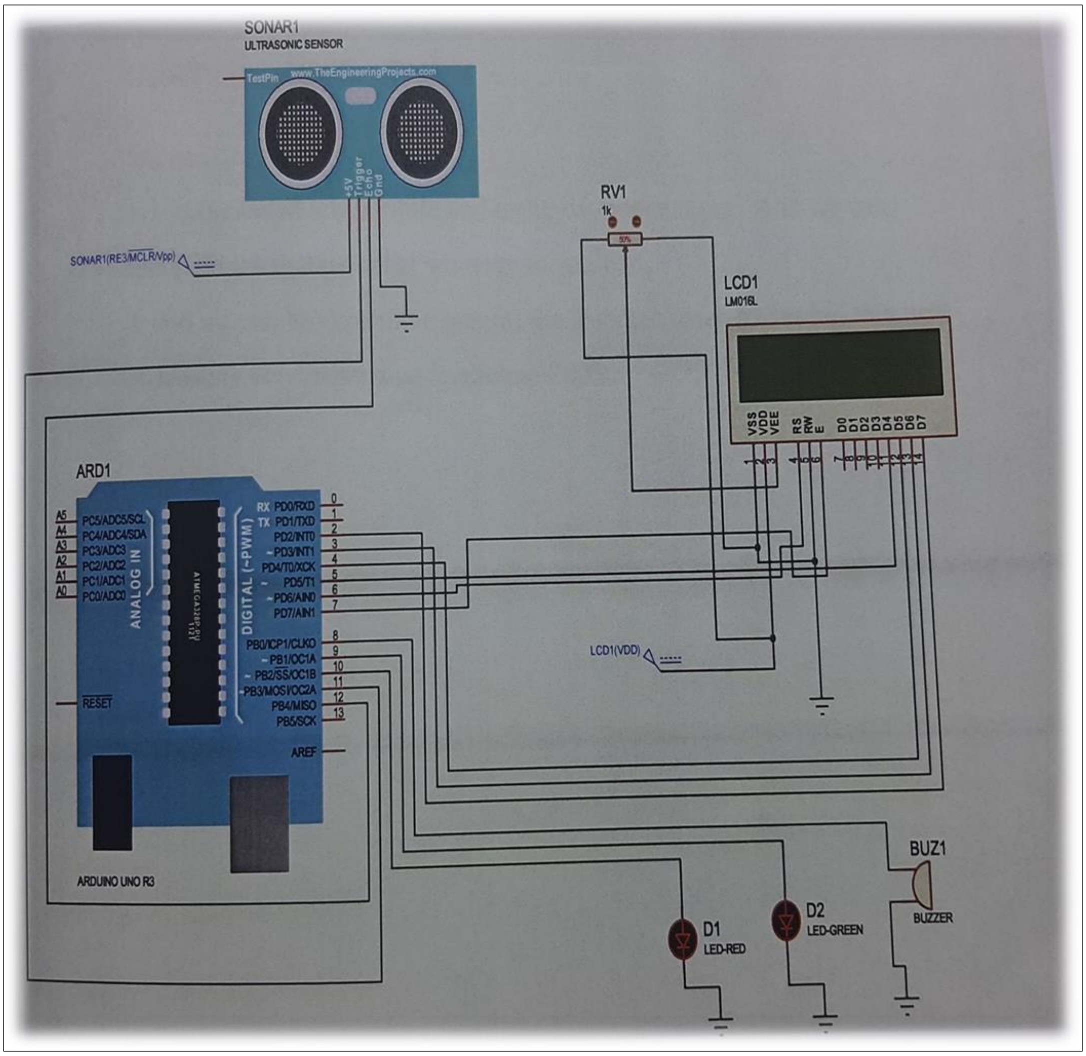

Figure 7 The circuit using the connect the devices software

9. Proposed system

- By connected it in mobile and using Wi-Fi technique , And we can specified the distance that we want to sense it.
- And we can be determine (sense) the distance reach to 8m but this type of sense is very expensive it reach to 200$.

10. Conclusion

Using Arduino for distance sensing in embedded systems provides a flexible and cost-effective solution for various applications. By integrating sensors like ultrasonic (HC-SR04), infrared, or LiDAR with Arduino, developers can create systems that accurately measure distances and interact with their surroundings.

Arduino's ease of programming and extensive community support make it an excellent choice for prototyping and implementing distance sensing in robotics, automation, and security systems. As technology advances, combining Arduino with AI and IoT can further enhance precision and efficiency, opening new possibilities for smart and autonomous applications.

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