Visvesvaraya National Institute of Technology (VNIT), Nagpur

Measurements and Instruments (ECL204)

Mini Project Report

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Contents

Project:
Water level Measurement using UltraSonic Sensor.

Aim:

To measure Water level of any container and detect the level of water in it using Ultrasonic sensor.

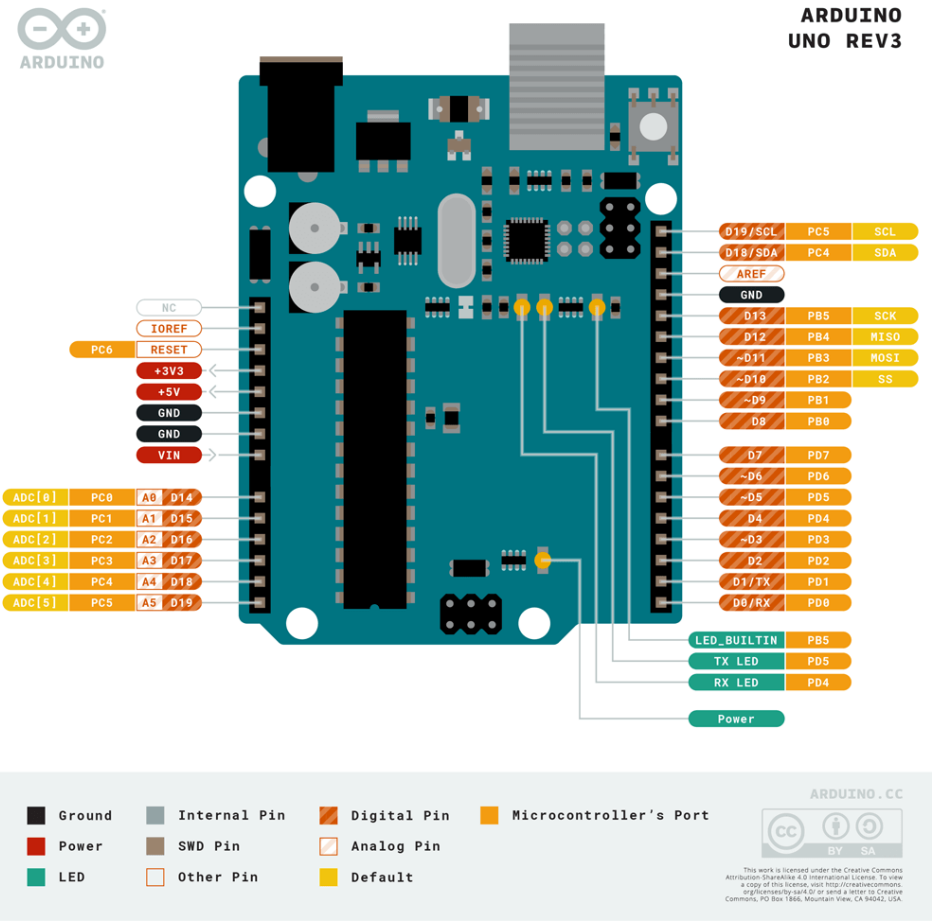
Requirements:

1.Arduino Uno board
2.Ultrasonic sensor
3.Resistor
4.8 LEDs
5.Passive buzzer
6.Connecting Wires
7.Battery
8.Transparent Container
9.Switch
10.Water

Concept:

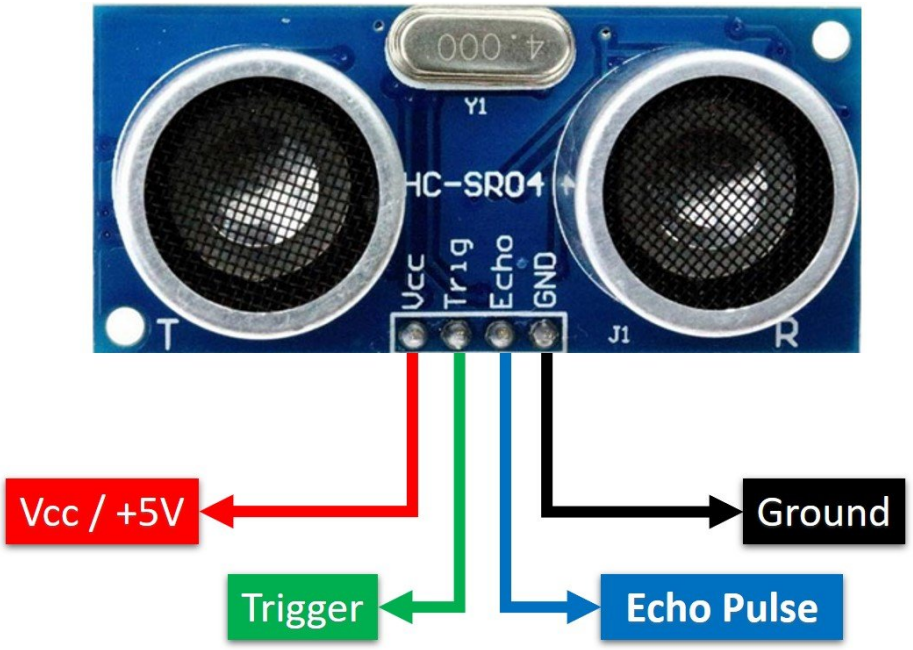
- **Arduino Uno:** The Arduino Uno comes with USB interface, 6 analog input pins, 14 I/O digital ports that are used to connect with external electronic circuits. Out of 14 I/O ports, 6 pins can be used for PWM output. It allows the designers to control and sense the external electronic devices in the real world.
  1. LED: There is a built-in LED driven by digital pin 13. When the pin is high value, the LED is on, when the pin is low, it is off.
  2. Vin: The input voltage to the Arduino board when it is using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
  3. 5V: This pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 20V), the USB connector (5V), or the VIN pin of the board (7-20V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage the board.
  4. 3V3: A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
  5. GND: Ground pins.
  6. IOREF: This pin on the Arduino board provides the voltage reference with

which the micro controller operates. A properly configured shield can read the IOREF pin voltage and select the appropriate power source, or enable voltage translators on the outputs to work with the 5V or 3.3V.
7. Reset: Typically used to add a reset button to shields that block the one on the board.



- **Ultrasonic sensor:** Ultrasonic sensors measure distance by using ultrasonic waves. The sensor head emits an ultrasonic wave and receives the wave reflected back from the target. Ultrasonic Sensors measure the distance to the target by measuring the time between the emission and reception. An optical sensor has a transmitter and receiver, whereas an ultrasonic sensor uses a single ultrasonic element for both emission and reception.
  Working of an HC-SR04 Sensor:-
  Ultrasonic sound vibrates at a frequency above the range of human hearing. Transducers are the microphones used to receive and send ultrasonic sound. HC-SR04 and like other ultrasonic sensor module use a single transducer to

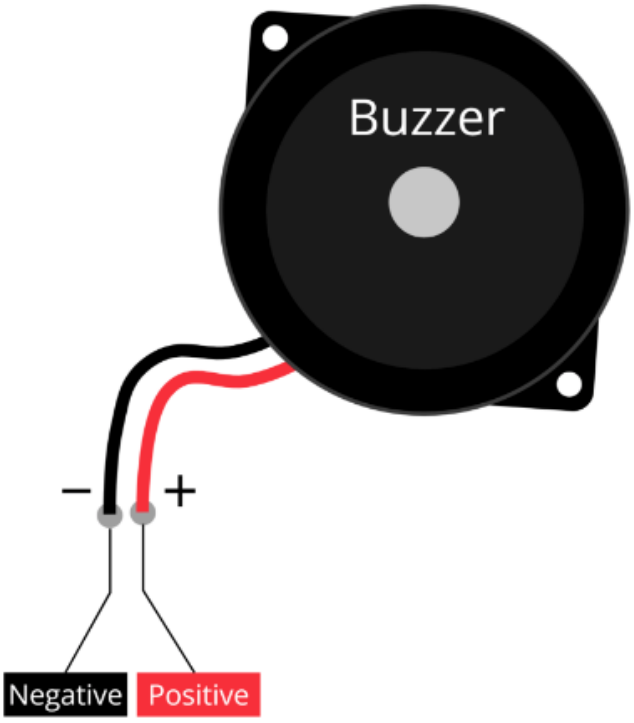
send a pulse and to receive the echo. The sensor determines the distance to the target by measuring time lapse between sending and receiving of the ultrasonic pulses.
Distance=(time taken×speed of sound)/2
The HC-RS04 Ultrasonic sensor module has 4 pins, two pins for power supply and one pin for sending out ultrasonic sound waves(TRIG) and one pin for receiving ultrasonic sound waves(ECHO).



- **LED:** A light-emitting diode (LED) is a semiconductor device that emits light when current flows through it. Electrons in the semiconductor recombine with electron holes, releasing energy in the form of photons. The color of the light (corresponding to the energy of the photons) is determined by the energy required for electrons to cross the band gap of the semiconductor.[5] White light is obtained by using multiple semiconductors or a layer of light-emitting phosphor on the semiconductor device.
  Advantages:
  1.Efficiency: LEDs emit more lumens per watt than incandescent light bulbs.The efficiency of LED lighting fixtures is not affected by shape and size, unlike fluorescent light bulbs or tubes.
  2.Color: LEDs can emit light of an intended color without using any color filters as traditional lighting methods need. This is more efficient and can lower initial costs.

3.Size: LEDs can be very small (smaller than 2 mm2) and are easily attached to printed circuit boards.
4.Switch on time: LEDs light up extremely quickly. A typical red indicator LED achieves full brightness in under a microsecond. LEDs used in communications devices can have even faster response times.
5.Cycling: LEDs are ideal for uses subject to frequent on-off cycling, unlike incandescent and fluorescent lamps that fail faster when cycled often, or high-intensity discharge lamps (HID lamps) that require a long time to warm up to full output and to cool down before they can be lighted again if they are being restarted.
Applications:
LED uses fall into five major categories:
1.Visual signals where light goes more or less directly from the source to the human eye, to convey a message or meaning.
2.Illumination where light is reflected from objects to give visual response of these objects.
3.Measuring and interacting with processes involving no human vision.
4.Narrow band light sensors where LEDs operate in a reverse-bias mode and respond to incident light, instead of emitting light.
5.Indoor cultivation, including cannabis.

- **Passive buzzer:**
  Passive buzzers need an AC signal to produce sound. the downside to this is that they will need more complex circuitry to control them, like an oscillating 555 timer or a programmable microcontroller like the Arduino.
  Passive buzzers have the advantage that they can vary the pitch or tone of the sound. Passive buzzers can be programmed to emit a wide range of frequencies or musical notes.
  In a passive buzzer, we find an anatomy similar to a loudspeaker. There is a circular magnet surrounding an inner wire coil, with a disk that vibrates from the magnetic force generated by the electromagnetic coil.



Simulation Code with comments:

- The code is as follows:

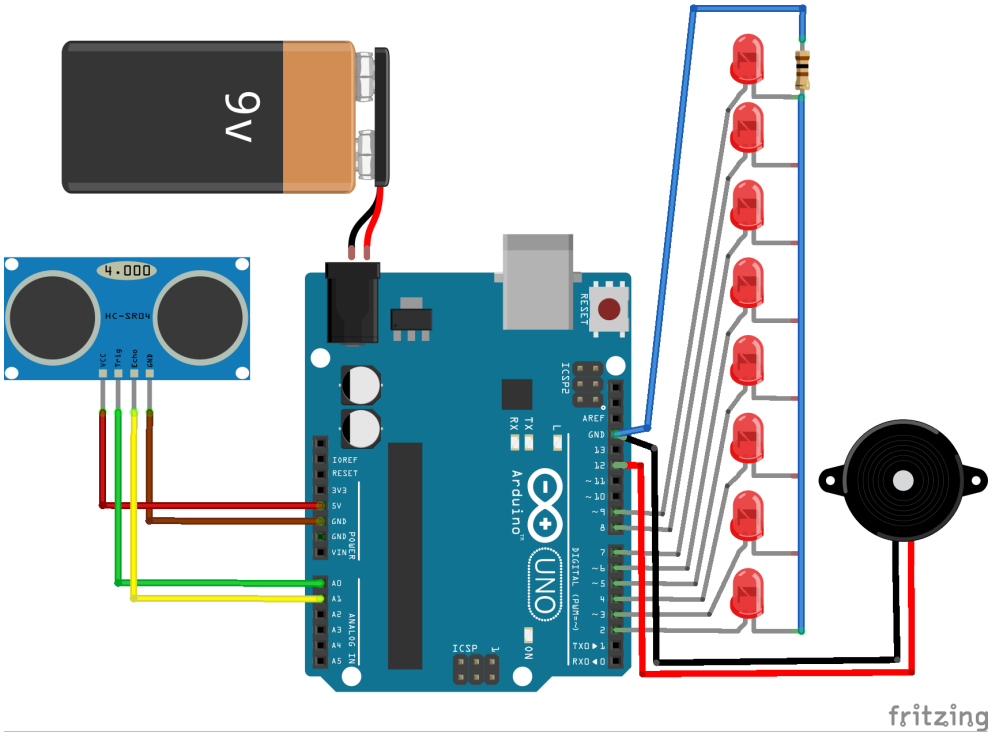
```
const int echo=A1;
const int trigger=A0;
long time;
float distance;
int leds[]={1,2,3,4,5,6,7,8,9,10};

void setup()
```

```
{
  for(int pin=2;pin≤11;pin++)
    pinMode(pin,OUTPUT);

  pinMode(echo,INPUT);
  pinMode(trigger,OUTPUT);
  Serial.begin(9600);
  delay(100);
}

void loop()
{
  gauge();

  Serial.print("Distance: ");
  Serial.print(distance);   // distance value is sent serially
  Serial.print("cm");
  Serial.println();

  indicator_level();
}

void gauge()
{
  digitalWrite(trigger,LOW);
  delayMicroseconds(2);
  digitalWrite(trigger,HIGH);
  delayMicroseconds(10);
  digitalWrite(trigger,LOW);

  time=pulseIn(echo,HIGH);  // us=microseconds
  distance = float(time*0.0343)/2;
  delay(10);
}

void indicator_level()
{
  if(distance>10) // maximum distance, turn off the LEDs
  {for(int k=0;k≤9;k++)
   {digitalWrite(leds[k],LOW);}
  }
else if(distance>9) // first level, turn on LED 1.
   {for(int k=0;k≤0;k++)
    {digitalWrite(leds[k],HIGH);}
    for(int k=1;k≤9;k++)
    {digitalWrite(leds[k],LOW);}
   }
else if(distance>8) // 2nd level, turn on LED 2, and so on ...
    with the other LEDs, etc...
```

```
56     {for(int k=0;k≤1;k++)
57      {digitalWrite(leds[k],HIGH);}
58      for(int k=2;k≤9;k++)
59      {digitalWrite(leds[k],LOW);}
60     }
61  else if(distance>7)
62     {for(int k=0;k≤2;k++)
63      {digitalWrite(leds[k],HIGH);}
64      for(int k=3;k≤9;k++)
65      {digitalWrite(leds[k],LOW);}
66     }
67  else if(distance>6)
68     {for(int k=0;k≤3;k++)
69      {digitalWrite(leds[k],HIGH);}
70      for(int k=4;k≤9;k++)
71      {digitalWrite(leds[k],LOW);}
72     }
73  else if(distance>5)
74     {for(int k=0;k≤4;k++)
75      {digitalWrite(leds[k],HIGH);}
76      for(int k=5;k≤9;k++)
77      {digitalWrite(leds[k],LOW);}
78     }
79  else if(distance>4)
80     {for(int k=0;k≤5;k++)
81      {digitalWrite(leds[k],HIGH);}
82      for(int k=6;k≤9;k++)
83      {digitalWrite(leds[k],LOW);}
84     }
85  else if(distance>3)
86     {for(int k=0;k≤6;k++)
87      {digitalWrite(leds[k],HIGH);}
88      for(int k=7;k≤9;k++)
89      {digitalWrite(leds[k],LOW);}
90     }
91  else if(distance>2) // last level, activate LED 8.
92     {for(int k=0;k≤8;k++)
93      {digitalWrite(leds[k],HIGH);}
94      tone(12,523, 100);
95      tone(12,450, 100);
96     }
97  }
```

- Ultrasonic sensor water level measurement is a technique used to determine the level of water in a tank or container using ultrasonic waves.The sensor emits high-frequency sound waves that bounce off the surface of the water and return to the sensor. By measuring the time it takes for the waves to travel back, the

sensor can calculate the distance to the water surface and thus determine the water level. This non-contact and highly accurate method has become popular due to its ease of use and reliability.



Procedure:

- We assemble the above circuit diagram as follows:
  1.Connect the Analog In 'A0' pin of arduino uno to 'Trig' pin of ultrasonic sensor and 'A1' pin to 'echo' pin.

  2.Connect the '5V' pin of arduino uno to 'Vcc' pin of ultrasonic sensor and 'GND' to 'GND' pin in both.

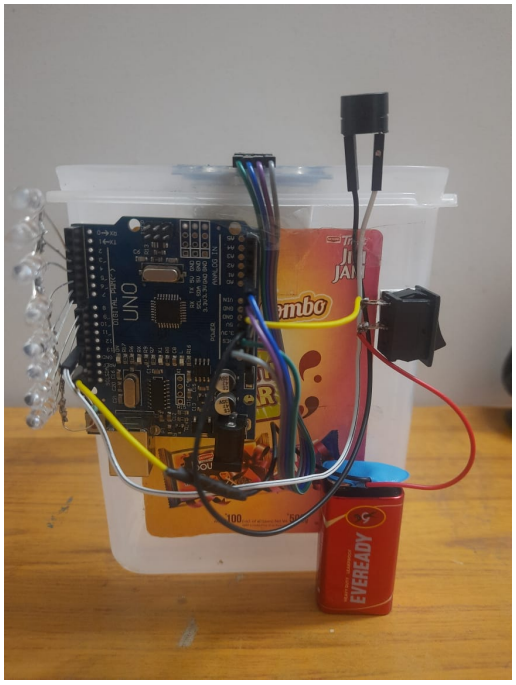
  3.Now solder the 8 LEDs to digital pins 2 'D2' to 'D9'. And connect a resistor along with the LEDs soldered to the 'GND' pin of arduino uno.

  4.Connect the two terminals of the passive buzzer to 'GND' and 'D12' pins of the arduino uno. And connect the battery to the power supply port.

  5.Now stick this setup using double tapes and cello tapes to the transparent container in such a way that the sensor sticks to the mouth of the container and you are ready to perform the experiment.

Output:

- We observe that the with increase in water level of the container, the number of LEDs that glows keeps on increasing, this happens due to the ultrasonic sensor that is present at the top, this detects the level of closeness of the water level to the top and when the 8th and last LED glows, the buzzer starts to ring indicating that the level of container is high.



Benefits:

- Benefits of using ultrasonic sensors in water level measurement:
  1.Ultrasonic sensors use piezo crystals to generate a mechanical pulse that is launched from the sensor membrane. This sound wave reflects off the surface of the process medium because of a change in density between air and the medium.The reflected pulse is then received at the sensor membrane.

  2.Because sensor is measuring water level with contact-less method water can stay unspoiled.

  3.High reliability, long term stability and accuracy.

  4.Requires very less maintenance and does not require external power sources.

  5.In addition to level measurement, ultrasonic sensors have a wide range of applications. They are used in robotics for obstacle detection and avoidance,

in automotive parking assist systems, and even in medical imaging devices.

Conclusion:

- In conclusion, ultrasonic sensors have proven to be an effective and reliable method for measuring water levels. They offer a non-contact solution, eliminating the need for physical contact with the water. This makes them ideal for various applications, such as tanks, reservoirs, and even rivers. Ultrasonic sensors are capable of providing accurate measurements, even in challenging environments. They are easy to install and require minimal maintenance. With their ability to measure water levels with precision, ultrasonic sensors have become a popular choice for many industries. Overall, ultrasonic sensor water level measurement is a practical and efficient solution for monitoring water levels.

References/ Citations:

1. lambdageeks.com
2. Youtube
3. Wikipedia