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SMART WATER MANAGEMENT SYSTEM USING IOT

ABSTRACTION

For human life and the health of the environment, water is important. We have created an automated water quality management system for home, workplaces, etc. in order to achieve the good water quality needed by the citizens through IoT. We have used different sensors to design a device to calculate the water pH, the water pressure, flow, temperature etc. In this paper, we have recommended the use of a smart interface sensor to track water reservoirs, track water contamination and monitor leakages from water pipelines
water leak detector in the pipelines and the pH sensor have been
used to monitor water quality and the wat
to track the water temperature. They use the ultrasonic sensor for tests. The automation of the system is demonstrated by LabVIEW Software. The device is powered by laptop / mobile phones. With this device installed in smart buildings, we can collect and evaluate the residents 'water usage habits and save a lot of water from waste.

INTRODUCTION

Currently, IoT and remote sensing techniques are being used for tracking, gathering and analyzing data from remote locations in various areas of study. Thanks to the tremendous increase in world industrial production, rural to urban drift and over-use of land and sea resources, people have undergone a major decrease in the quality of water available. In the sector of mining and construction the heavy use of fertilizers in farming and other chemicals have
contributed enormously to the global reduction of water quality.
In IoT water solutions, the data ingest from water supplies can be precisely monitored so that water is handled effectively and efficiently. IoT's intelligent water management has had a huge impact on water treatment costs and has rendered a cost-effective urban water delivery. The IoT advantages in water management are harvested particularly from the agricultural sector.

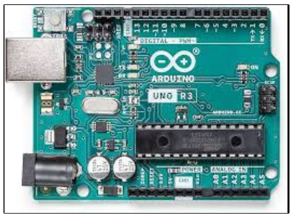
OBJECTIVES

- Reduce wasting water
- Improved water quality
- Improve the efficiency of water systems
- Implement leakage control

REQUIREMENTS SPECIFICATIONS

HARDWARE COMPONENTS:

ARDUINO UNO:



ARDUINO Arduino/Genuino Uno is a microcontroller board based on the ATmega328P (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller. Simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. Arduino is the heart of our project which is used to control sensors and Wifi module.

NODEMCU (ESP8266):

Nodemcu contains built in Esp8266 wifi module which is used to communicate with server thus the sensor data are uploaded into server by connecting to a Wifi Hotspot. We can simply connect our mobile hotspot to the nodemcu and obtain the readings.

WATER FLOW SENSOR:

It is used to measure or sense the flow of the water using Hall Effect. Water flow sensor gives an amazing solution for measuring the flow rate of liquids. Huge industrial plants, commercial and residential buildings require a large amount of water supply. The public water supply system is used to meet this requirement. To monitor the amount of water being supplied and used, the rate of flow of water has to be measured. Water flow sensors are used for this purpose. Water flow sensors are installed at the water source or pipes to measure the rate of flow of water and calculate the amount of water flowed through the pipe. Rate of flow of water is measured as liters per hour or cubic meters.

POWER SUPPLY

Power supply circuit, the name itself indicates that this circuit is used to supply the power to other electrical and electronic circuits or devices. We have used 5V DC regulated power supply circuits, which can be designed for converting the available 230V AC power to 5V DC power. 3.5 GSM MODULE It is a mobile communication modem that is connected to a PCB with different types of output and to Arduino board. It helps in establishing communication by inserting a sim card into the slot. This module helps in sending alert message to the programmed number. Once the connection is established successfully, the status/network LED will blink continuously every 3 seconds. You may try making a call to the mobile number of the sim card inside GSM module. 3.6 LIQUID CRYSTAL DISPLAY It is a 16 pin interface that allows us to control LCD display with 5x7 pixel matrix.

SOFTWARE DEVELOPMENTS

Arduino IDE is open-source software that is mainly used for writing and compiling the code into the Arduino Module. It is official Arduino software, making code compilation to easy that even a common person with no prior technical knowledge can easily work on it. Arduino Uno program is fed into the compiler. Arduino Uno can once be compiled and saved for future use, thus the programmed code works as soon as the supply is fed to the Arduino board and the readings are updated.

Water leakage detection

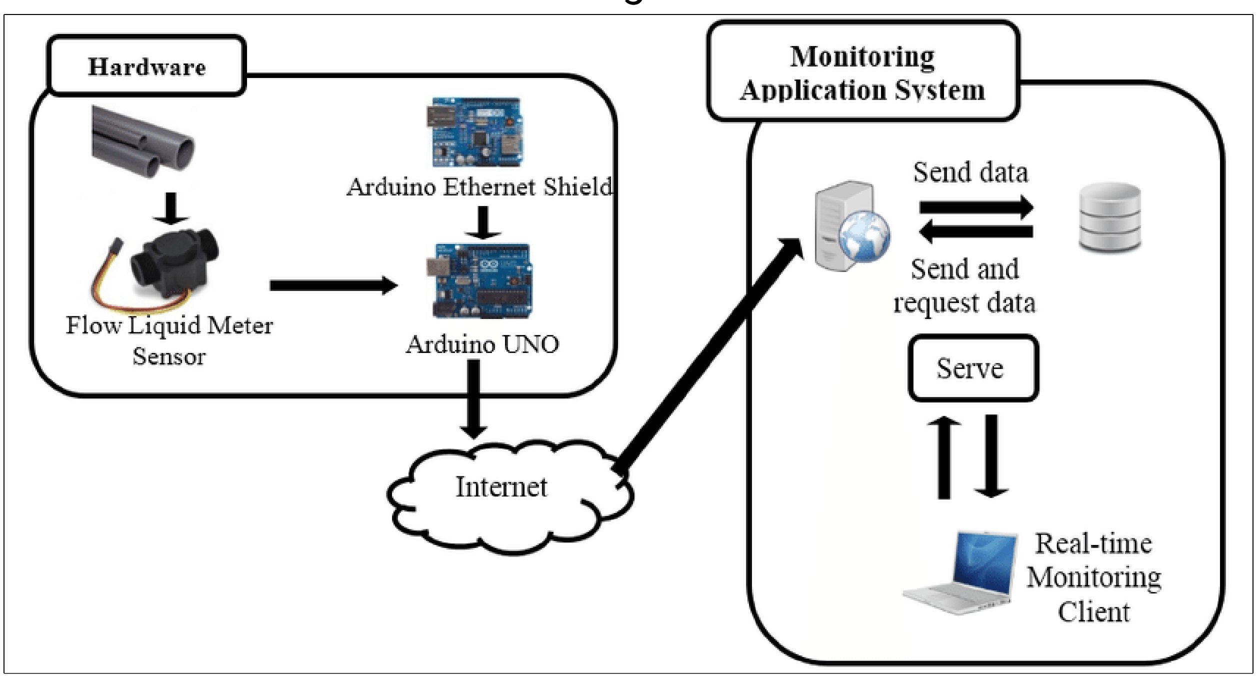
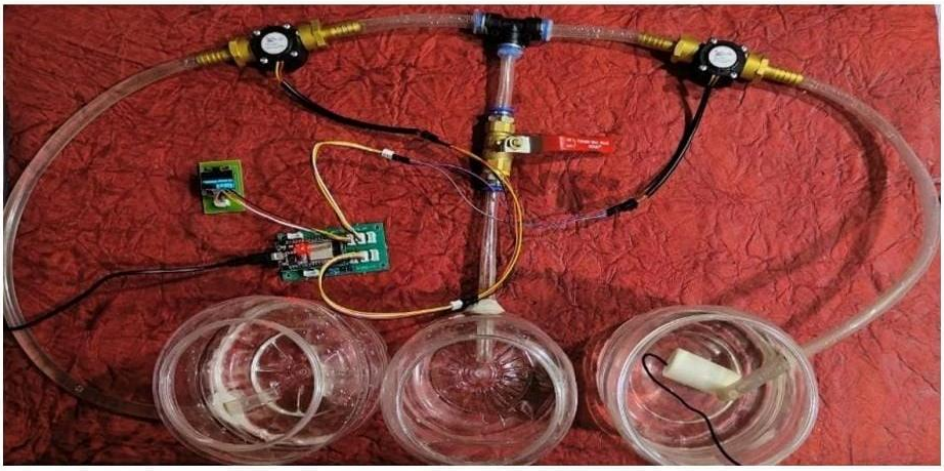


Fig:Block diagram of water leakage detection system

SMART WATER MANAGEMENT SYSTEM USING IOT

Water leakage detection system



Our proposed smart water leakage detection system aims to overcome the limitations of the existing manual inspection methods by offering an automated, sustainable and proactive approach to detecting water leakage . The system combines the power of microcontrollers, sensors, and an OLED display to provide real-time monitoring, accurate detection, and timely alerts.

WORKING ALGORITHM

Input: Water inflow
Output: Leakage or not

Step 1: Two water flow sensors has to be intilized

Step 2: Place one at pumping water tanks and second one at destination (house)

Step 3: water flow between the source and destination

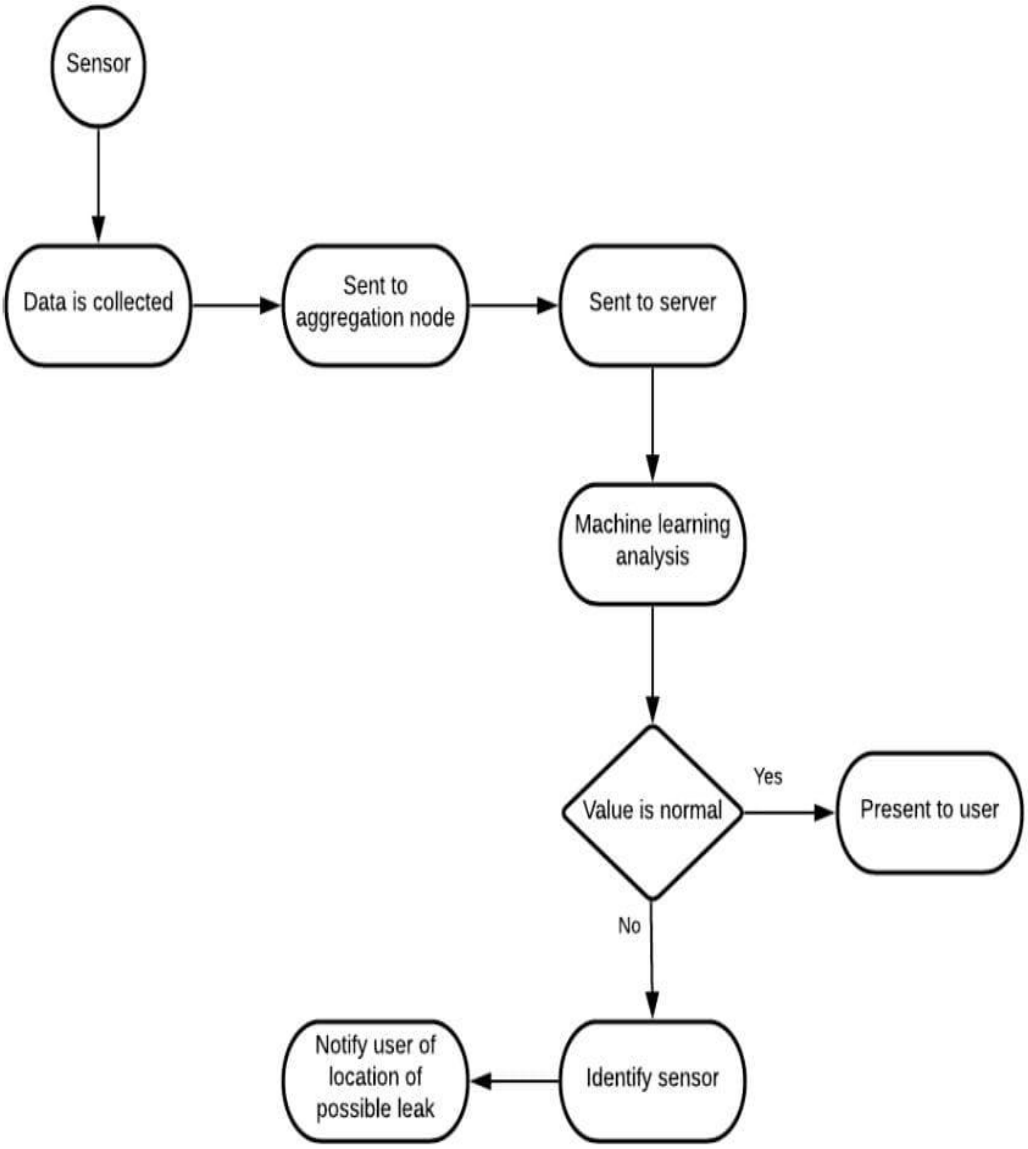
Step 4: void pulseCounter() { // Increment the pulse counter pulseCount++; } void pulseCounter1() { // Increment the pulse counter pulseCount1++; }

Step 5: flowRate = ((1000.0 / (millis() - oldTime)) * pulseCount) / calibrationFactor; flowRate1 = ((1000.0 / (millis() - oldTime)) * pulseCount1) / calibrationFactor; difference = flowRate - flowRate1; if(difference>2) {digitalWrite(led, HIGH); // turn the LED on (HIGH is the voltage level) delay(1000); // wait for a second digitalWrite(led, LOW); }

Step 6: based on step 5 the light will on (if water leak) or of(no water leak)
Step 7: It will send to mobile app for notification

Step 8: step 6 to step 7 will continue for ever.

System logic



SMART WATER MANAGEMENT SYSTEM USING IOT

WATER LEAKAGE DETECTION

SYSTEM ANALYSIS:

The data used for the project was collected from a housing complex having 16 households. The height of the water tank as well as the requirement of the household plays an important role in determining the working of the whole process of start ing and stopping the motor. The water tanks installed were Syntax 1,000 L tanks having 109.98 cm radius and 122.43 cm height. There was no inflow of water in the tanks at the time of monitoring. The tank system is as shown infollowing figure1.1.

Fig:1.1

WORKING OF ULTRASONIC SENSOR

The Arduino kit including the UV sensor was installed on the top of one of the two tanks, to monitor the water level after every 10 seconds. This ultrasonic sensor sends UV rays to measure the distance of water level from the top of the tank using SONAR. The sensor sends the ultrasonic waves to water level, which is reflected by the water surface and comes back to the ultrasonic sensor. Sensor uses this time of wave propagation to calculate the distance between the sensor and the water level. Time taken by the pulse is actually to and fro for travel of the ultrasonic signals, while only half of this is needed. Therefore, the time is time /2.

DISTANCE CALCULATION

Distance ¼ speed*time/2 Speed of sound at sea level ¼ 343 m/s or 34,300 cm/s Thus the distance measured ¼ 17150* time (unit cm) Boyle et al. With the help of that distance, the water level and hence the volume of water consumed can be calculated since the height and radius of the tank are fixed.

WORKING WIFI MODULE

The Wi-Fi module can connect to internet via hotspot by using its SSID and Password. It has been programmed to implement logic statements as per requirements of the pro ject. The ultrasonic sensor reads the distance of water surface and returns it to the module. The module, when con nected to internet, uploads this value to the database. The water level to be monitored for each tank is collected by the ultrasonic sensor and simultaneously the data collected is shifted to the server via ESP12-e

DATA ANALYTICS

Feature space and response variables
We have considered the following parameters in defining the feature space for the SVM algorithm:
(a) Volume of water consumed (cu cm), (b) Number of users, (c) Temperature (C) and (d) Precipitation (mm).

The response variables for SVM consist of:
(a) Average Water Consumption per user per day and (b) Prediction of Water Consumption per user per day.
The algorithm for leakage detection considered the fol lowing parameters:
(a) Input variables are Water Level Initial, Water Level Final and In Use.
(b) Response Variables include Leakage detected (yes/No) and Leakage Rate (cubic cm/sec).
SVM based classification
SVM has been used for analysis purposes, since it is highly accurate and the preferred method for data sets with small size [Ray]. SVM is also less prone to over fitting than other methods and facilitates compact model for classification. Kernel Function, radial basis function (RBF) is used since the data is not linearly separable [Ng] and is the most commonly used kernel in support vector machines. Finally, the optimal hyper-plane is found, which makes maximum empty spaces at two sides of coordinate.

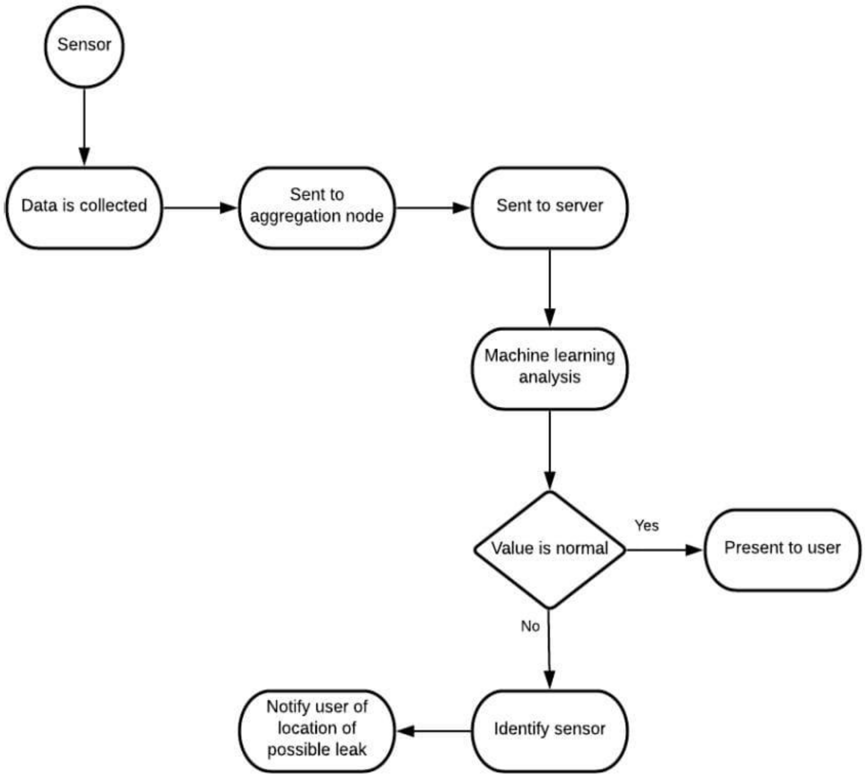


Fig1.2.system logic

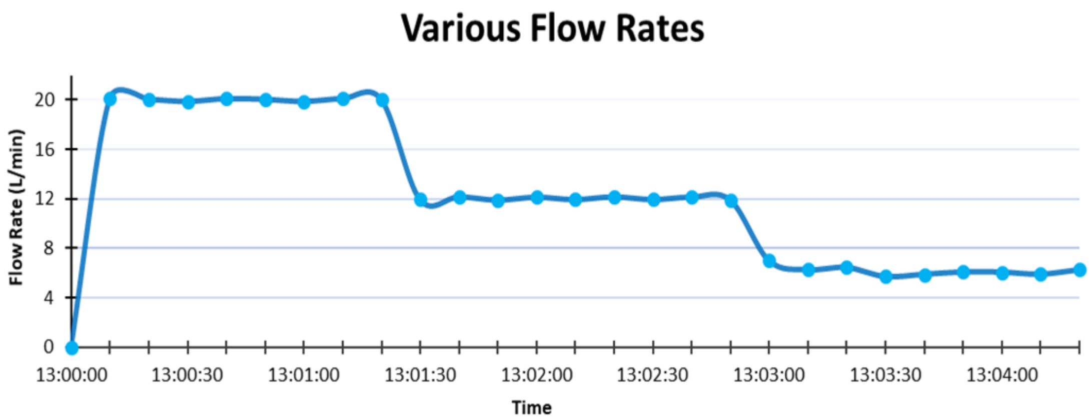


Fig1.3Graph of water flow rate at various conditions.

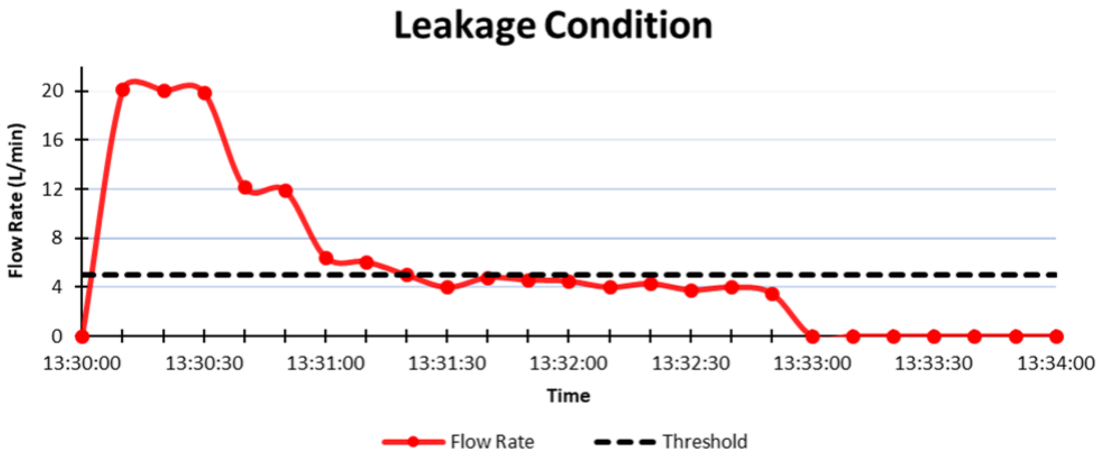


Fig 1.4. Graph of the leakage condition

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WATER LEAKAGE DETECTION

1.PROJECT DESCRIPTION:

Ultrasonic water sensor brick is designed for water detection, which can be widely used in sensing rainfall, water level, and even liquid leakage.Connecting a Ultrasonic water sensor to an Arduino is a great way to detect a leak, spill, flood, rain, etc. It can be used to detect the presence, the level, the volume and/or the absence of water.While this could be used to remind you to water your plants, there is a better Grove sensor for that. The sensor has an array of exposed traces, which read LOW when water is detected.we will connect the water sensor to Digital Pin on Arduino, and will enlist the very handy LED to help identify when the water sensor comes into contact with a source of water.

2.PROJECT IMPLEMENTATION:

Using ultrasonic detection sensor also we detect the water flow level. We take ultrasonic sensor from Arduino simulation tool and we place on the simulation . We use Arduino simulation for this project.Arduino software tool was taken from the component tool. Ultra Sonic sensor,led , connecting wires as per required taken from component tool.

Empty components taken. We connect led negative pin to ground (voltage in).Next we connect the wire from sensors VCC to vin. Connect the negative pin to the ground from the sensor or short to the led to the ground pin. Connect the echo pin to D22. Connect the trigger pin to D19 .

Then we run the simulation with the help of source code.

2.1SENSOR:

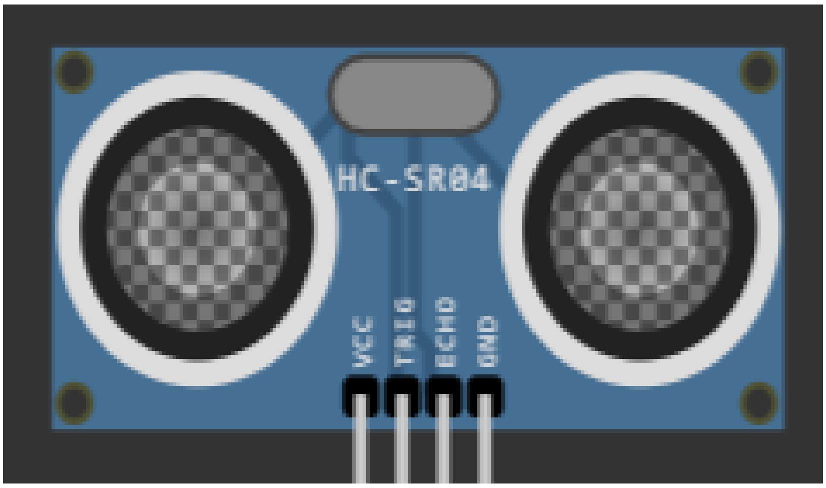

Fig 2.1:Ultra sonic detection sensor

3. CIRCUIT DIAGRAM:

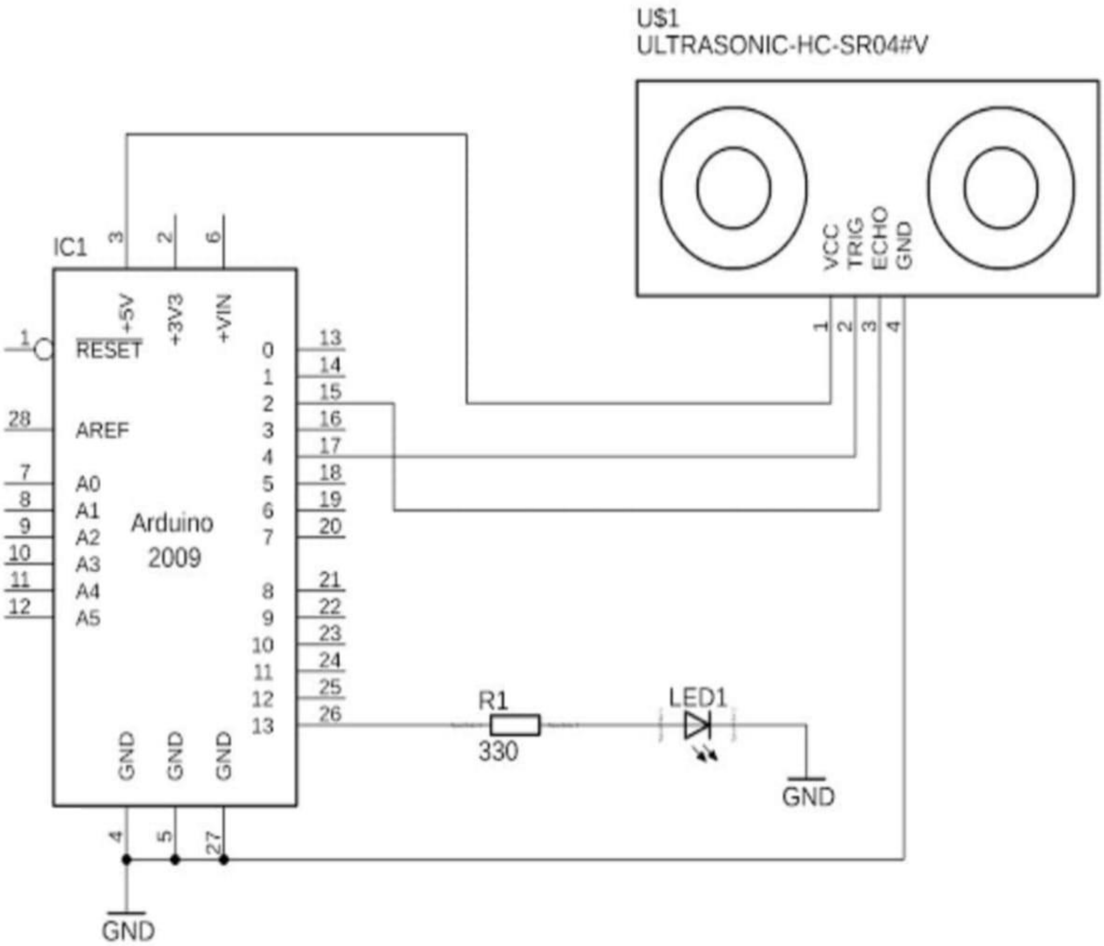

Fig 3:Circuit Diagram of water detection system

4.SOURCE CODE:

4.1.FRONT END(Python):

```
import machine
import time

# Pin assignments for the ultrasonic sensor
TRIGGER_PIN = 23  # GPIO23 for trigger
ECHO_PIN = 22     # GPIO22 for echo

# Pin assignment for the LED
LEAK_LED_PIN = 19  # GPIO19 for the LED

# Set the pin modes
trigger = machine.Pin(TRIGGER_PIN, machine.Pin.OUT)
echo = machine.Pin(ECHO_PIN, machine.Pin.IN)
leak_led = machine.Pin(LEAK_LED_PIN, machine.Pin.OUT)

# Function to measure distance using the ultrasonic sensor
def measure_distance():
    # Generate a short trigger pulse
    trigger.value(0)
    time.sleep_us(5)
    trigger.value(1)
    time.sleep_us(10)
    trigger.value(0)

    # Measure the echo pulse duration to calculate distance
    pulse_start = pulse_end = 0
    while echo.value() == 0:
        pulse_start = time.ticks_us()
    while echo.value() == 1:
        pulse_end = time.ticks_us()

    pulse_duration = pulse_end - pulse_start

    # Calculate distance in centimeters (assuming the speed of sound is
343 m/s)
    distance = (pulse_duration * 0.0343) / 2  # Divide by 2 for one-way
travel
```

```
    return distance

# Function to check for a water leak
def check_for_leak():
    # Measure the distance from the ultrasonic sensor
    distance = measure_distance()

    # Set the threshold distance for detecting a leak (adjust as needed)
    threshold_distance = 10  # Adjust this value based on your tank setup

    if distance < threshold_distance:
        # If the distance is less than the threshold, a leak is detected
        return True
    else:
        return False

# Main loop
while True:
    if check_for_leak():
        # Blink the LED to indicate a leak
        leak_led.value(1)  # LED ON
        time.sleep(0.5)
        leak_led.value(0)  # LED OFF
        time.sleep(0.5)
    else:
        leak_led.value(0)  # LED OFF

    time.sleep(1)  # Delay between measurements
```

4.2.BACK END(JSON):


```json
{
  "version": 1,
  "author": "Uri Shaked",
  "editor": "wokwi",
  "parts": [
    { "type": "wokwi-esp32-devkit-v1", "id": "esp", "top": -14.5, "left": 81.4, "attrs": {} },
    { "type": "wokwi-led", "id": "led2", "top": 6, "left": -111.4, "attrs": { "color": "blue" } },
    { "type": "wokwi-hc-sr04", "id": "ultrasonic1", "top": -113.7, "left": -71.3, "attrs": {} }
  ],
  "connections": [
    [ "esp:TX0", "$serialMonitor:RX", "", [] ],
    [ "esp:RX0", "$serialMonitor:TX", "", [] ],
    [ "ultrasonic1:GND", "esp:GND.2", "black", [ "v0" ] ],
    [ "ultrasonic1:ECHO", "esp:D22", "green", [ "v0" ] ],
    [ "ultrasonic1:TRIG", "esp:D23", "green", [ "v0" ] ],
    [ "ultrasonic1:VCC", "esp:VIN", "red", [ "v0" ] ],
    [ "led2:A", "esp:D19", "green", [ "v0" ] ],
    [ "led2:C", "esp:GND.1", "black", [ "v0" ] ]
  ],
  "dependencies": {}
}
```

4.3SAMPLE OUTPUT SCREENSHOTS:

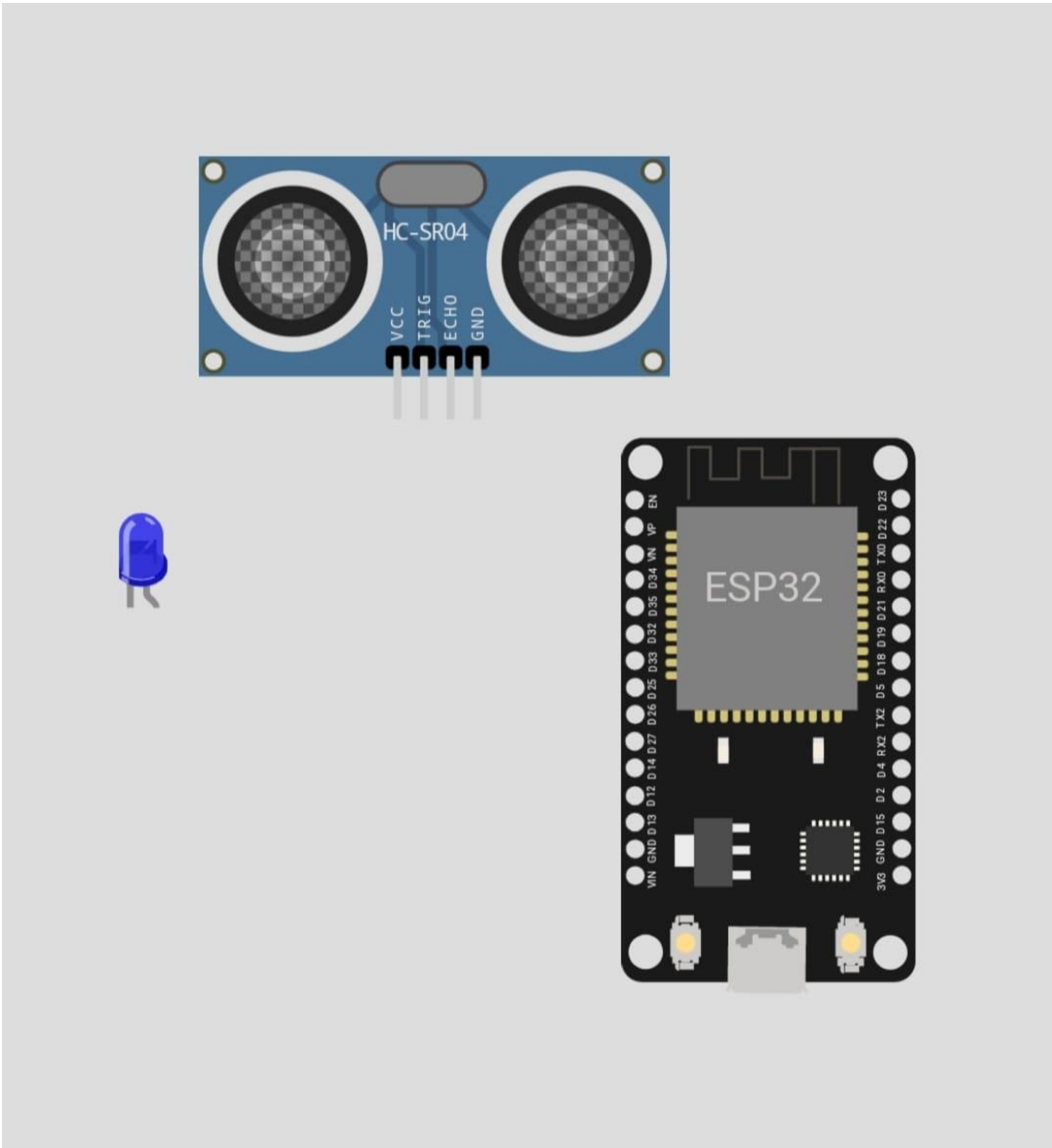

Fig:4.3.1:Take the components needed

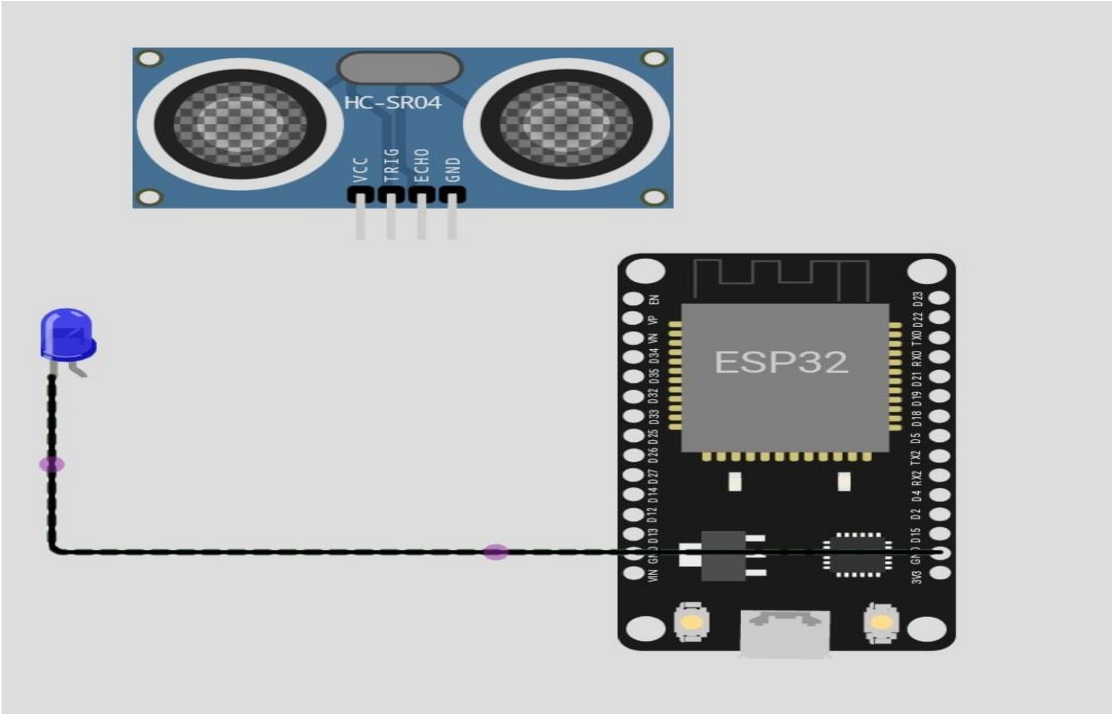

Fig4.3.2:Led negative pin connected to the ground

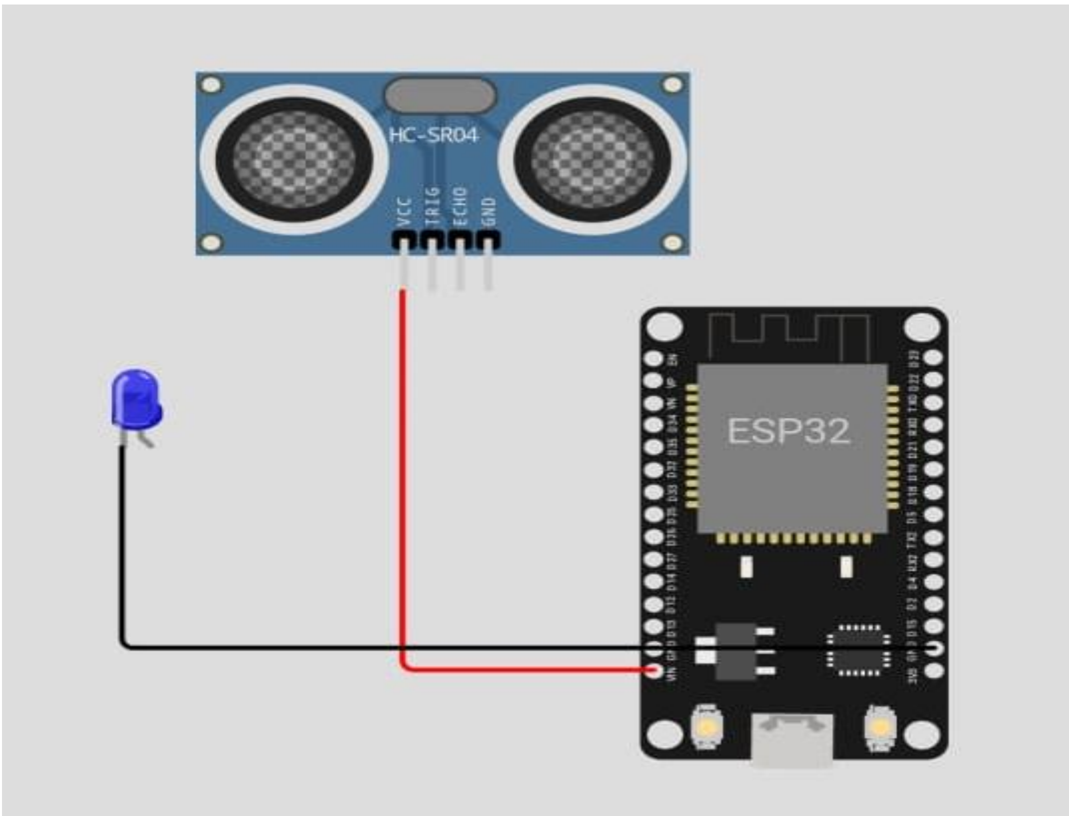

Fig:4.3.3:VCC connected to VIN

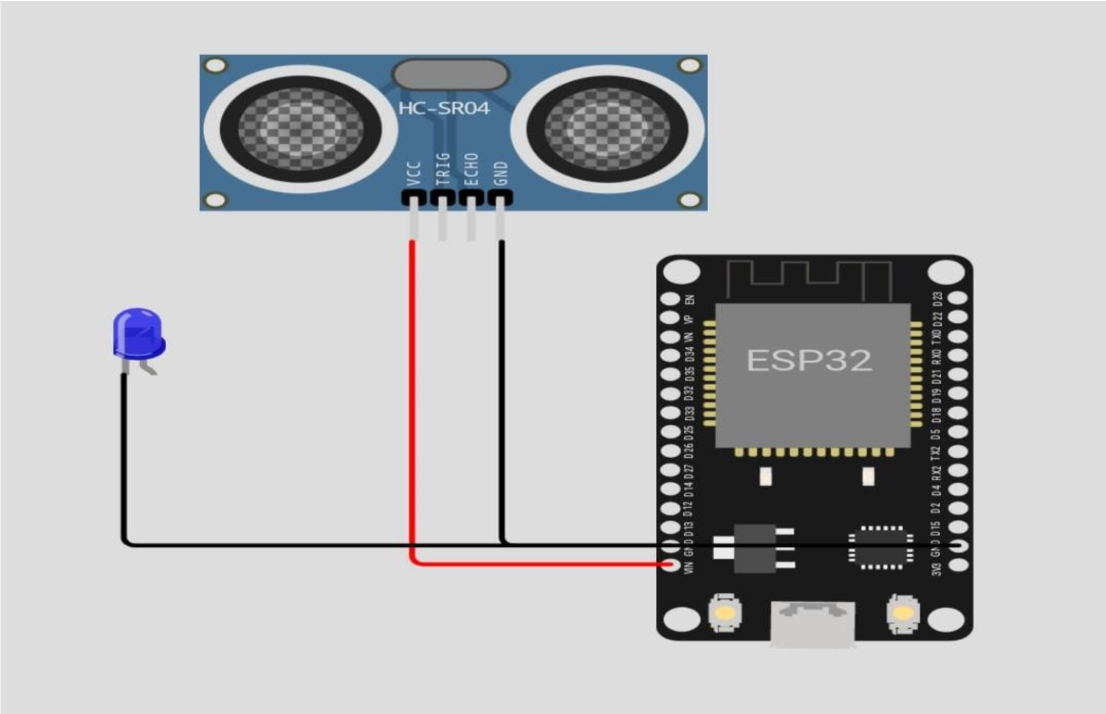

Fig:4.3.4:Ground connections are given

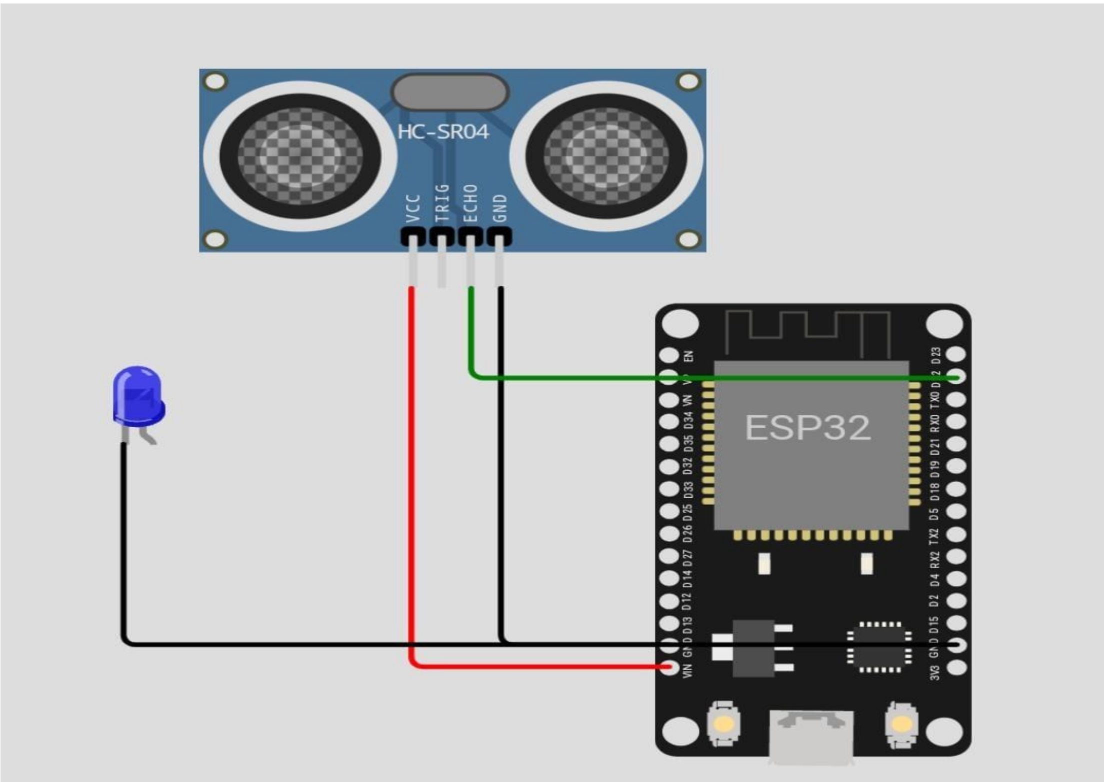

Fig:4.3.5:Echo pin connected to D22

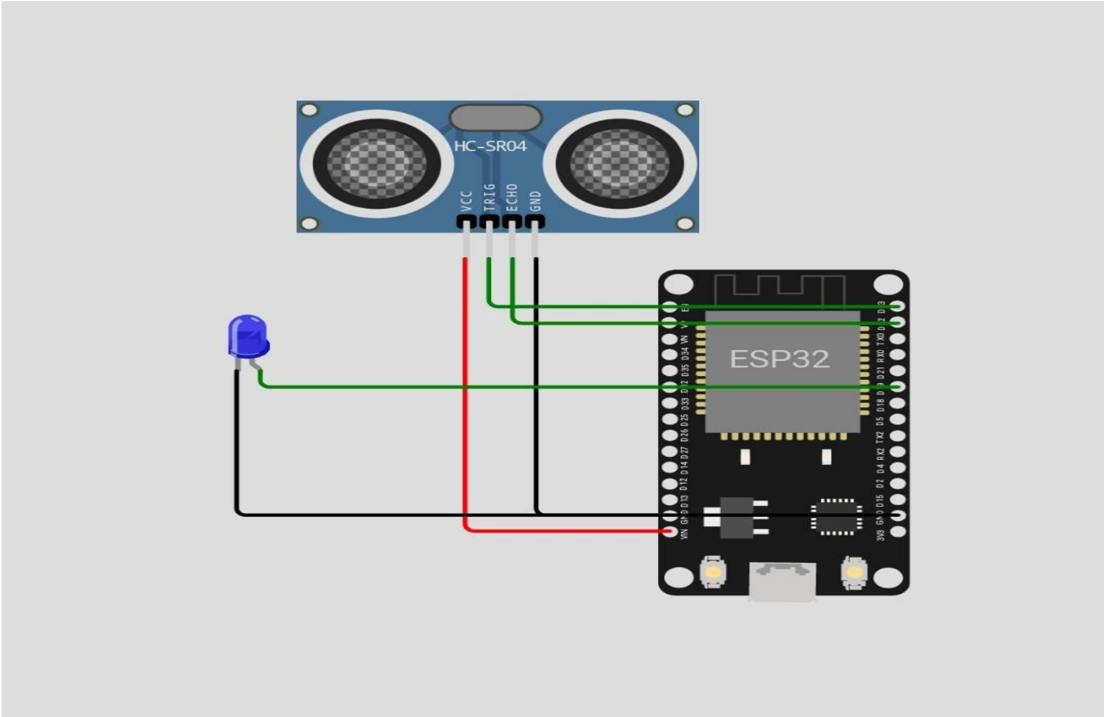

Fig:4.3.6:TRIG pin connected to D23

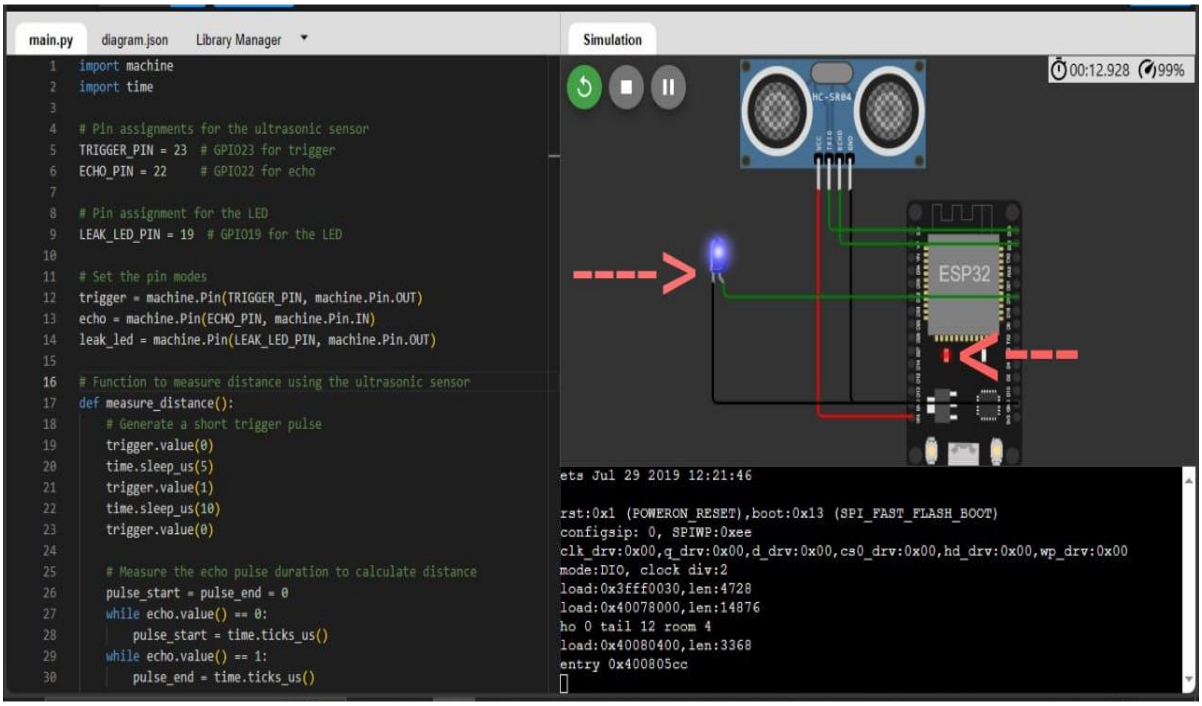

Fig:4.3.7:Final output

You will see the indication LED turn ON when the sensor detects water.You will see the indication LED turn ON when the sensor detects water.

Conclusion and future enhancement

mandatory to prevent it from getting wasted due to any pipeline leaks. Hence the designed prototype is an effective solution for monitoring the flow of water as well as detecting for leaks in the pipelines. The smart water leakage detection system can help in water distribution process by remote activation of solenoid valves. Usage of cloud logging technique enables the data acquisition and analysis in any point of the pipeline. This system makes cost efficient and simple. The flow of water through the domestic pipeline can be monitored, forecasted and visualize from anywhere in the world using internet through computer or Smartphone. The collected data can be analyzed for making predictions to the users for demand management, asset management, and leakage management. With water as a flowing liquid the system has been tested successfully. The work can be extended to forecast data for larger communities with customer satisfaction involving low cost and better performance of the overall system.
The location of the leak has determining a maximum distance of 2 meters and it can determine the location of the leak closest to the actual location of the leak with an average flow rate of 10 liters per minute. One plan in the future work is to extend the detection ability to more than 2 meters, which later on can be developed by considering the time duration of the reduction in water flow rate when there is a leak, so the accuracy of the leakage location is improved. Another future work is to implement the detection system to branched pipelines as well as using various water flow rates.

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