Water Level Detection System

By

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About the Author

Thomson Kaisi Junior (23 years old) is a student from University of Malawi, Studying Bachelor of Science degree program. He is majoring in Computer Network Engineering and Minoring in Electronics and Computer Science. He has much passion in system development, Networking and Application development.

He has worked in different projects, among the projects include development of an IOT based Incubator for hatching portly eggs.

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Dedication

For Sandra Sazuze, My wonderful mother who has always been there for me. She is a prayerful and hard working woman, my source of joy.

Acknowledgments

My friend, Precious Chaonekera (Apprah Anderson) has always been there for me when I was working on this project. He has always been encouraging me to move forward when I was passing through tough situations in the course of this project.

Special recognition should also go to Mr. Don Mkavea who has always been my mentor in different aspects of life.

Abstract

Water is the fundamental resource of everyday activities. It is used for different purposes in homes and industries. In homes it is used for irrigation, drinking and cooking while in industries it is used in production and treatment, hence contributing to the economy of the state and societies. In Malawi like any other country we have different sources of water, these include: Lake, rivers and Dams.

Due to increase in Population availability and continuous supply of clean water has been a problem in Malawi especially in large cities. According to Drop4Drop, in 2015 one in ten people did not have an access to clean water due to series of droughts, flooding and population growth. A research conducted by Water Aid in 2019 indicated that one in three (which represent 5.6Million people) people do not have access to clean water in Malawi. This has led to serious health problems in our societies, for example, more than 3,100 children under the age of five dies every year from diarrhoea caused by dirty water and poor sanitation. The research also indicated that about 73% of Health Care facilities don't have access to a sanitation facility due to lack clean water access in Malawi (Water Aid).

Despite having a limited supply of clean water in our country, good water management technics can help to reduce or even eradicate other problems caused by lack of clean water supply. One of the technic that can be applied to in order ensure clean water is being access by high percentage of the population is to control wastage of water in both homes and industries. This can be achieved by monitoring water levels in different reservoirs in order to prevent loss of water caused by overflow pipes in water tanks.

Introduction

Water Level Detection System can be defined as a collection of different electronic components in order to monitor amount of water in different water reservoirs. These electronic components include sensors that measures the level of water and micro-controllers that process results captures by the sensors.

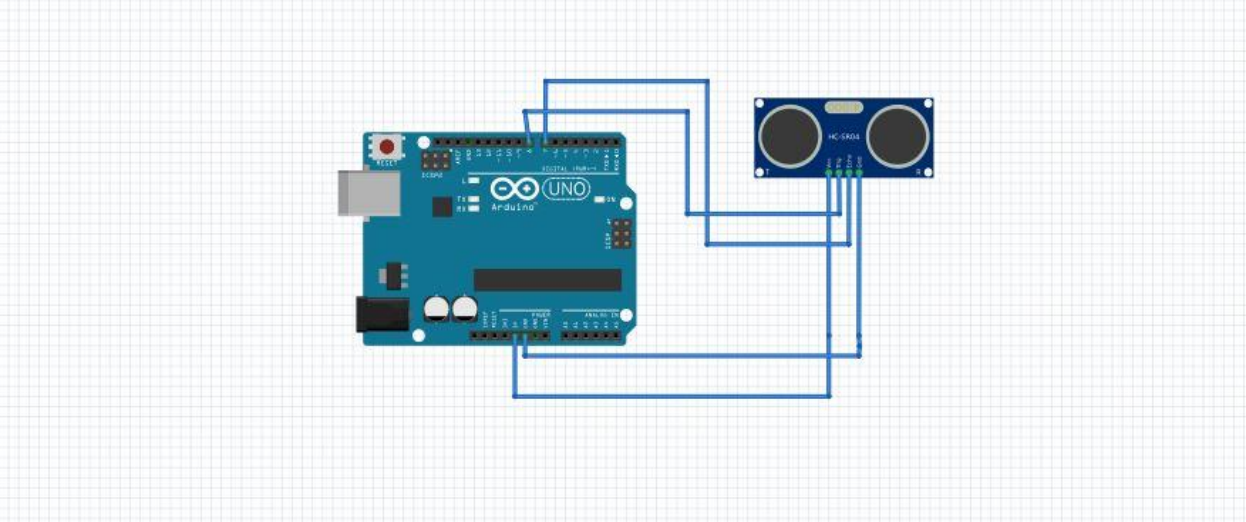
Methodology

How the System is connected

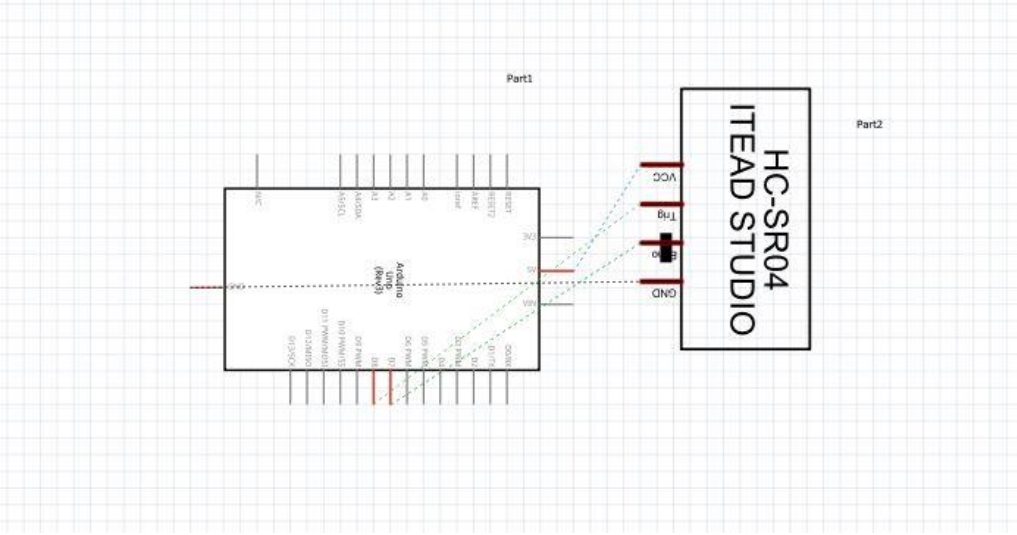
1. **Circuitry Connection**

An ultrasonic sound sensor is connected to an Arduino Uno using four connecting wires. A ground pin of the sensor is connected to the ground of an Arduino, The positive pin of the sensor is connected to 5v VCC positive terminal of an Arduino. The trigger pin and echo pins of the sensor is connected to digital pin 7 and 8 of an Arduino Uno respectively. The Arduino Uno is connected to the computer which is powering the system and is acting as a server using serial data link.

The figure below show the circuit diagram in both pictorial and schematic view of an Arduino Uno and Ultrasonic sound sensor (HC-SR04).



Pictorial View



Schematic View.

2. **Architecture of the System**
   A 10 liters bucket has been used to act as reservoir for water. This bucket has a funnel at the top which is used to pour water into the bucket. An ultrasonic sensor has been placed on the

top lead of the bucket where two speaker of the sensor are facing directly to the base of the bucket. An Arduino Uno has been placed adjacent to the sensor.

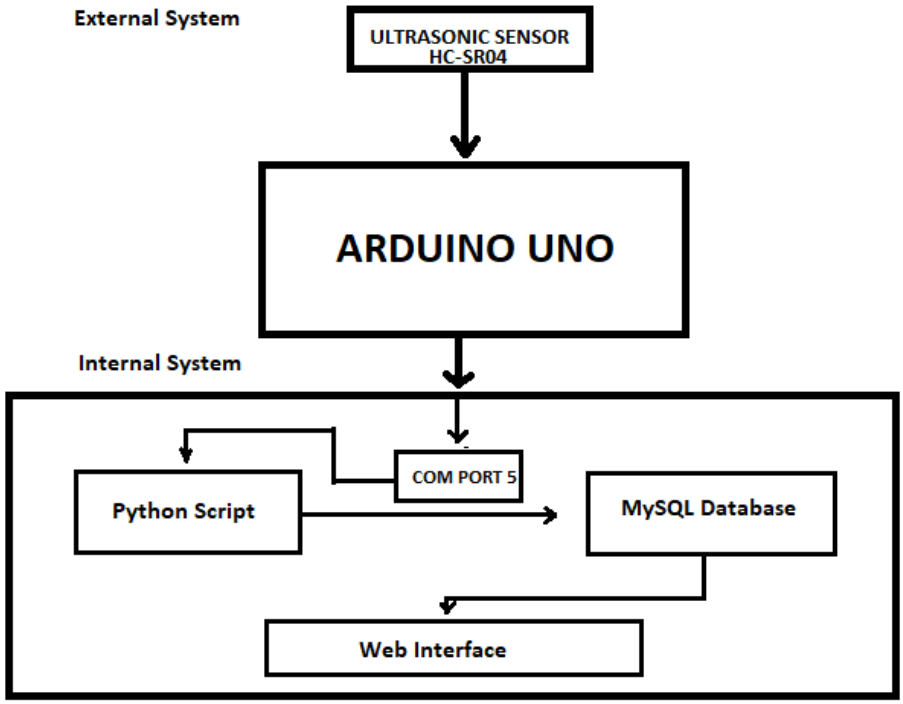
The figure below shows the architecture of the System

The distance from the sensor to the bottom of the bucket is 26cm. The radius of the bucket is 7cm

3. STRUCTURE OF THE SYSTEM

There are two subsystem which are external System and Internal System. The external system comprises of Ultrasonic sensor, the Arduino Uno, Bucket and the funnel. The External System is connected to an internal system using a serial bus. The Internal system is a software component of the system running on a Computer which is acting as server. It comprises of a python script which is collecting data from Arduino through COM port 5 and this data is being sent to MySQL database.

The figure below show the block diagram of the system



4. HOW THE SYSTEM WORKS

Ultrasonic sound sensor measures the distance from the surface of water to itself. It sends sound waves from the transmitting speaker to the surface of water in the bucket. When the waves reach at the surface they bounces back to the receiving speaker. Once the waves are sent by the transmitting speaker the Arduino starts counting the time taken from the point of transition until it is received back by the receiving speaker. The time counter stops when waves are received. The distance from the sensor to the surface is calculated as follows:

Let ***d*** represents the duration taken by the wave from point of transmission to the point where it is received back.

Let ***s*** be the speed of sound in air which is 343km/s

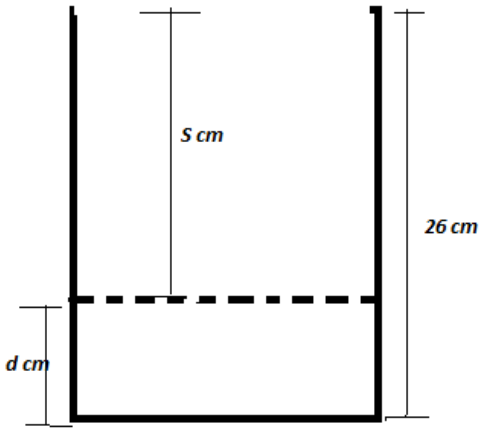
The distance from the sensor to the surface of water is calculated as follows:

$$Distance = \frac{duration\ taken\ by\ wave(d) x speed\ of\ sound\ in\ air(s)}{2}$$

We are diving by 2 since the time taken for the waves to reach back the receiving speaker is twice the time taken for the waves to reach the surface of water. For us to get the distance in cm we will need to convert the speed to cm/s. This means that the speed is 0.0343cm/s

When the Arduino calculate the distance from the surface of water to the sensor, the results are transferred to a text file in the computer (server) through serial bus which is connects Arduino to computer. Once the results are in the text file a python script reads from this file and manipulates the results. The manipulation works as follows:

Python script subtracts any distance calculated by the Arduino from 26cm (Since the distance from the sensor to the bottom of the bucket is 26cm) to get the actual distance covered by water. The figure below shows the distance measured by the sensor and the distance covered by water.



Suppose the distance from the sensor to the surface of water is ***S cm*** as indicated in the diagram and the distance covered by water is ***d cm***. To get the distance covered by water we need to subtract S from 26cm to get d. That is:

$$d = 26cm - S\ cm$$

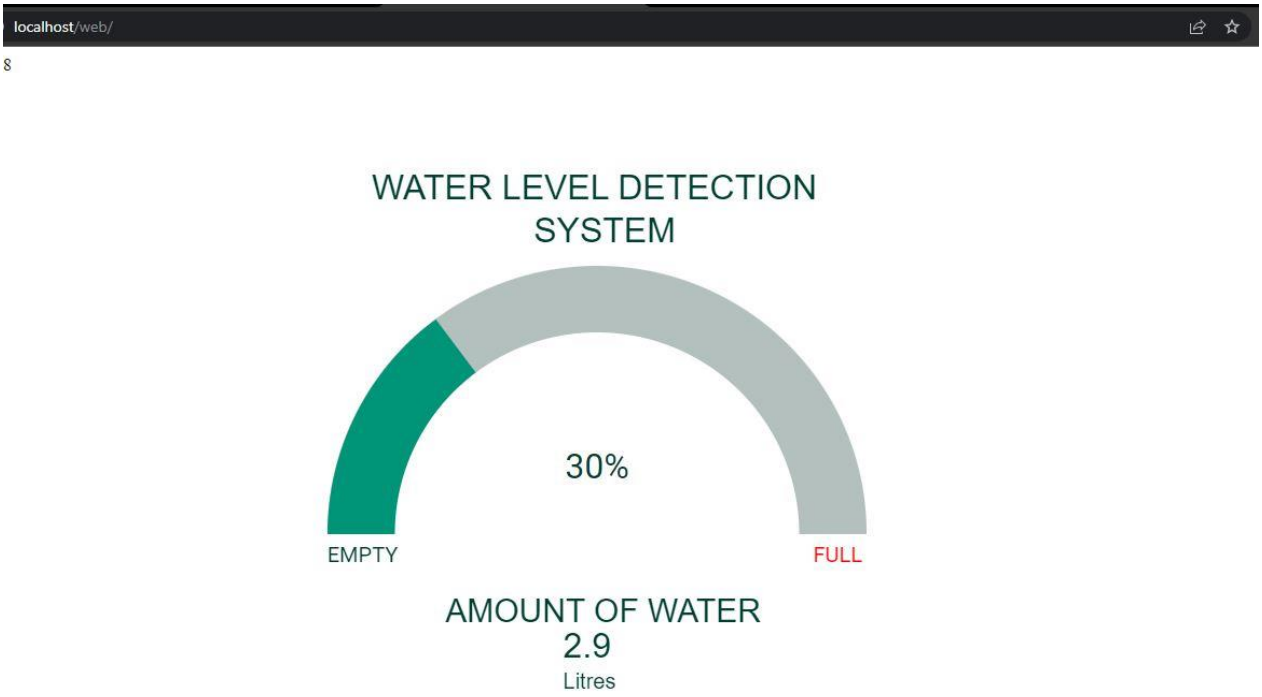
Once the Python script calculates the distance covered by water the results are uploaded to MySQL Database which is running in the server (Computer). The Database is connected to a XAMP web server which is serving as a User-interface to the system. On the web interface the distance is shown in percentage which reflects how the bucket has been filled with water. There is a gauge which is indicating the level of water in the bucket. Apart from indicating the level of water, the interface is also showing the volume of water poured into the bucket. This is being calculated as follows:

Since the distance from the bottom of the bucket to the top is 26cm and the volume of the bucket is 10 liters then volume of water is:

$$Volume = \frac{level\ of\ water(cm)x10litres}{26cm}$$

The equation above gives the volume of water in liters. The volume above is calculated by the php script in the web server.

The figure below shows the Graphical User-Interface of the system.



The interface of the system can be accessed anywhere in the world by just typing the

IP Address of the server on a web browser. For experimental purpose we are using a private IP Address as such it can only be accessed within a Local Area Network.

Short-falls of the System

The system was supposed to be powered by batteries and these batteries was supposed to be charged by a solar panel, but due to lack of enough resources we fail to implement this. We were supposed to embed our system with a Wi-Fi-module so that data may be sent wirelessly to the computer from an Arduino.

CONCLUSION

Availability and continuous supply of water can be achieved by using different water management technics. The project has suggested that the development of Water Level Detection System can greatly contribute in achieving availability and continuous supply of clean water in different parts of Malawi.

APPENDIX

1. Python Script

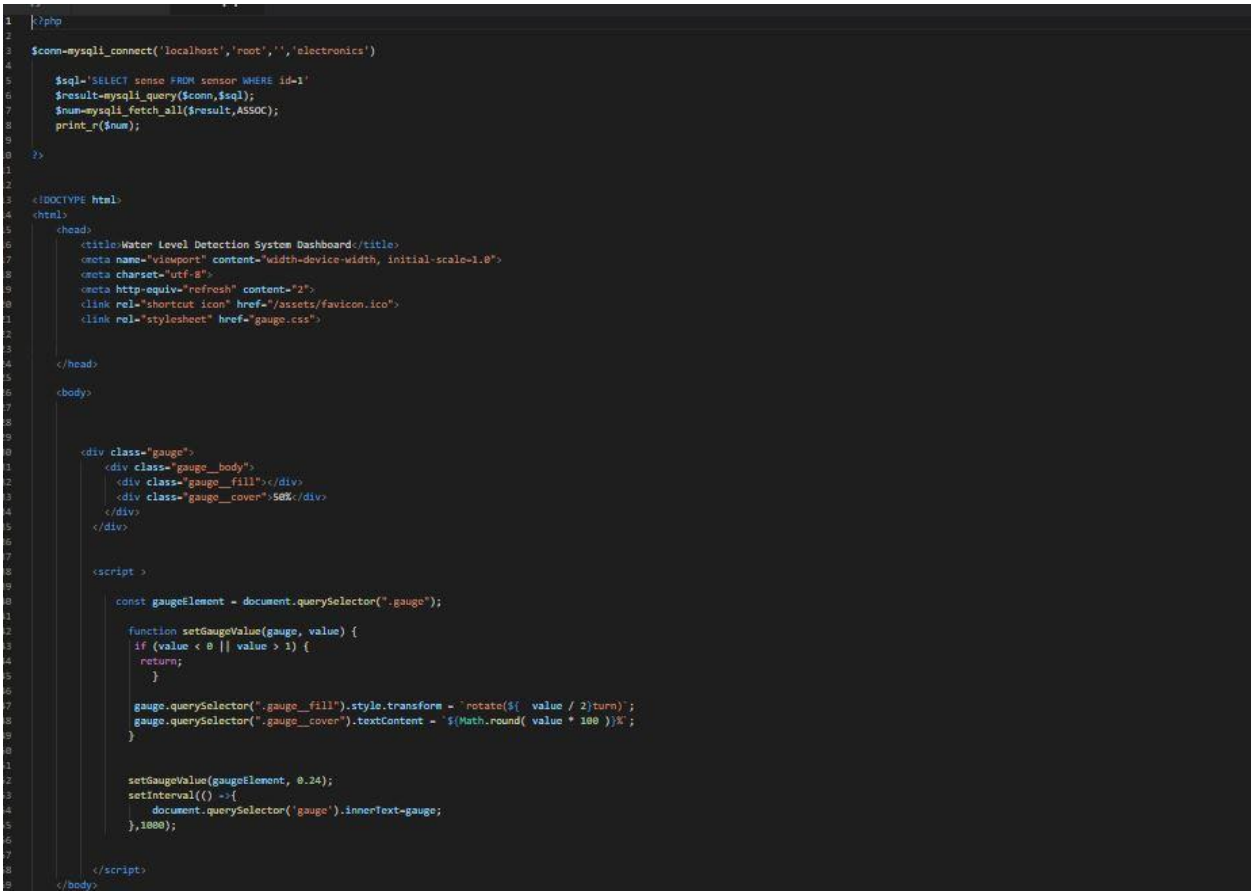
```python
import mysql.connector
from mysql.connector import Error

while True:
        file=open("water.txt","r")
        x=file.read()
        x=x.split("\n")
        y=float(x[-2])
        z=y-1
        w=26-z
        if w<=1:
            w=0
        x=w*100/26


       # print(x[-2])
        try:

            connection =mysql.connector.connect(host='localhost',database='electronics',user='root',password='')
            if connection.is_connected():
                    cursor=connection.cursor()
                    cursor.execute(f"UPDATE sensor SET sense={x} WHERE id=1;")
                    connection.commit()
        except Error as e:
            print("Error while connecting to Mysql")

```

2. Arduino Uno Program

```
//-----------------------------------------------------------
//Developed by: Thomson Kaisi and  Kinlos Kaliwo
//Water Level Detection system.
//Arduino Uno code for sensing distance and transfering to Python Script

//defining Pins for the ultrasonic sensor
#define echoPin 7


#define trigPin 8

// defines variables
long duration; // variable for the duration of sound wave travel
float distance; // variable for the distance measurement
float dis;//calibrator

void setup() {
  pinMode(trigPin, OUTPUT); // Sets the trigPin as an OUTPUT
  pinMode(10,OUTPUT);
  pinMode(echoPin, INPUT); // Sets the echoPin as an INPUT
  Serial.begin(9600); // // Serial Communication is starting with 9600 of baudrate speed
  Serial.println("Ultrasonic Sensor HC-SR04 Test"); // print some text in Serial Monitor
  Serial.println("with Arduino UNO R3");
}
void loop() {
  // Clears the trigPin condition
  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);
  // Sets the trigPin HIGH (ACTIVE) for 10 microseconds
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);
  // Reads the echoPin, returns the sound wave travel time in microseconds
```

```
    duration = pulseIn(echoPin, HIGH);
    // Calculating the distance
    dis = duration * 0.0343 / 2; // Speed of sound wave divided by 2 (go and back)
    // Displays the distance on the Serial Monitor
   // Serial.print("Distance: ");
   distance=dis;

      Serial.println(distance);
    delay(1000);
  if(distance<=3){
    digitalWrite(10,HIGH);
    delay(10000);
    digitalWrite(10,LOW);
    }

   // Serial.println(" cm");

  }
```

3. Php Script

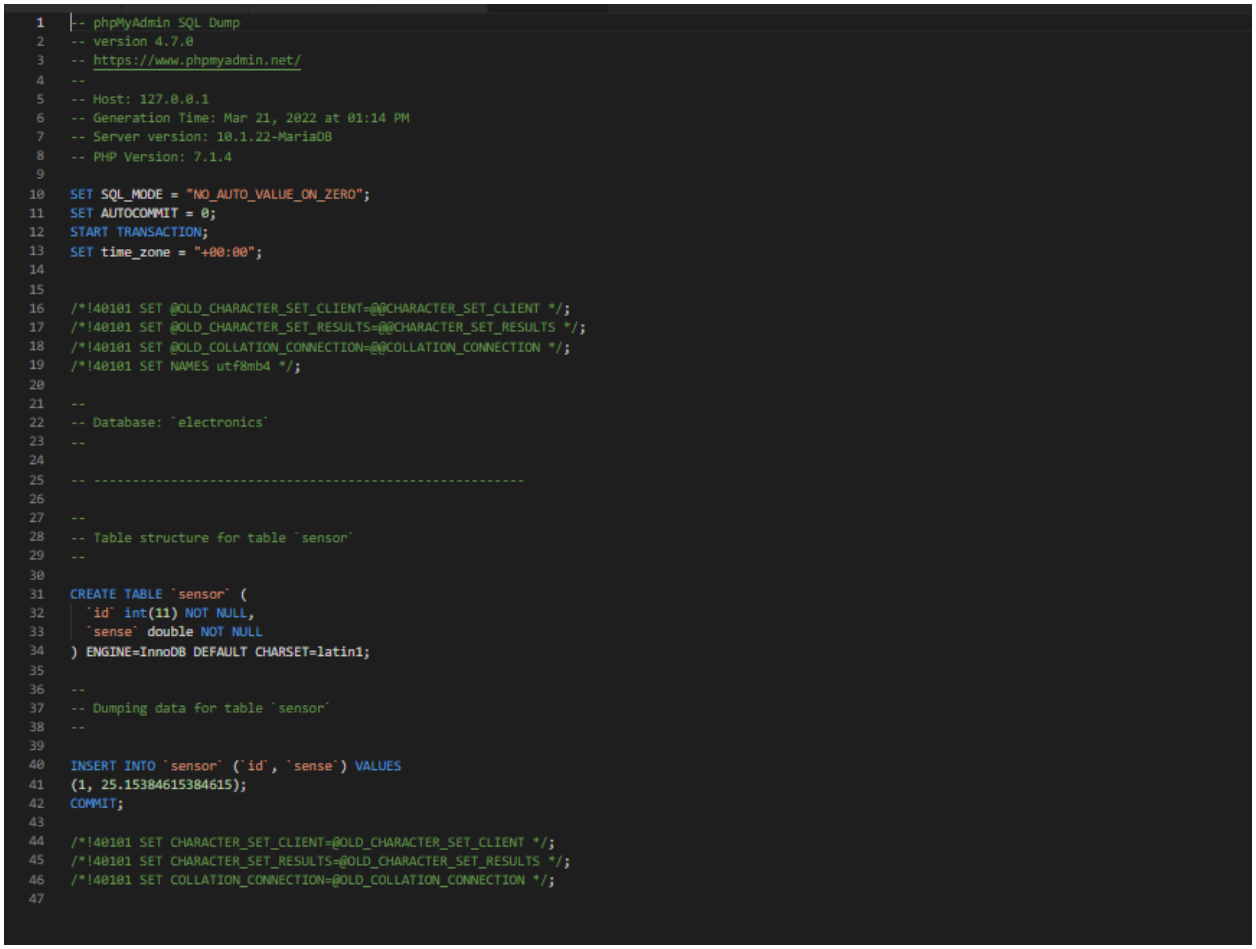


```php
<?php

$conn=mysqli_connect('localhost','root','','electronics')

    $sql='SELECT sense FROM sensor WHERE id=1'
    $result=mysqli_query($conn,$sql);
    $num=mysqli_fetch_all($result,ASSOC);
    print_r($num);

?>


<!DOCTYPE html>
<html>
    <head>
        <title>Water Level Detection System Dashboard</title>
        <meta name="viewport" content="width=device-width, initial-scale=1.0">
        <meta charset="utf-8">
        <meta http-equiv="refresh" content="2">
        <link rel="shortcut icon" href="/assets/favicon.ico">
        <link rel="stylesheet" href="gauge.css">


    </head>

    <body>



        <div class="gauge">
            <div class="gauge__body">
              <div class="gauge__fill"></div>
              <div class="gauge__cover">50%</div>
            </div>
          </div>


          <script >

            const gaugeElement = document.querySelector(".gauge");

              function setGaugeValue(gauge, value) {
               if (value < 0 || value > 1) {
                return;
                  }

               gauge.querySelector(".gauge__fill").style.transform = `rotate(${  value / 2}turn)`;
               gauge.querySelector(".gauge__cover").textContent = `${Math.round( value * 100 )}%`;
              }


              setGaugeValue(gaugeElement, 0.24);
              setInterval(() =>{
                  document.querySelector('gauge').innerText=gauge;
              },1000);


          </script>
    </body>
```

4. CSS Code

```css
.gauge {

    position: fixed;
    top:50%;
    left:50%;
    width: 150%;
    max-width: 500px;
    margin: auto;
    font-family: "Roboto", sans-serif;
    font-size: 32px;
    color: #004033;
    transform: translate(-50%,-50%)

  }

  .gauge__body {
    width: 100%;
    height: 0;
    padding-bottom: 50%;
    background: #b4c0be;
    position: relative;
    border-top-left-radius: 100% 200%;
    border-top-right-radius: 100% 200%;
    overflow: hidden;
  }

  .gauge__fill {
    position: absolute;
    top: 100%;
    left: 0;
    width: inherit;
    height: 100%;
    background: #009578;
    transform-origin: center top;
    transform: rotate(0.25turn);
    transition: transform 0.2s ease-out;
  }

  .gauge__cover {
    width: 75%;
    height: 150%;
    background: #ffffff;
    border-radius: 50%;
    position: absolute;
    top: 25%;
    left: 50%;
    transform: translateX(-50%);

    /* Text */
    display: flex;
    align-items: center;
    justify-content: center;
    padding-bottom: 25%;
    box-sizing: border-box;
  }

```

5. Database



```sql
-- phpMyAdmin SQL Dump
-- version 4.7.0
-- https://www.phpmyadmin.net/
--
-- Host: 127.0.0.1
-- Generation Time: Mar 21, 2022 at 01:14 PM
-- Server version: 10.1.22-MariaDB
-- PHP Version: 7.1.4

SET SQL_MODE = "NO_AUTO_VALUE_ON_ZERO";
SET AUTOCOMMIT = 0;
START TRANSACTION;
SET time_zone = "+00:00";


/*!40101 SET @OLD_CHARACTER_SET_CLIENT=@@CHARACTER_SET_CLIENT */;
/*!40101 SET @OLD_CHARACTER_SET_RESULTS=@@CHARACTER_SET_RESULTS */;
/*!40101 SET @OLD_COLLATION_CONNECTION=@@COLLATION_CONNECTION */;
/*!40101 SET NAMES utf8mb4 */;

--
-- Database: `electronics`
--

-- --------------------------------------------------------

--
-- Table structure for table `sensor`
--

CREATE TABLE `sensor` (
  `id` int(11) NOT NULL,
  `sense` double NOT NULL
) ENGINE=InnoDB DEFAULT CHARSET=latin1;

--
-- Dumping data for table `sensor`
--

INSERT INTO `sensor` (`id`, `sense`) VALUES
(1, 25.15384615384615);
COMMIT;

/*!40101 SET CHARACTER_SET_CLIENT=@OLD_CHARACTER_SET_CLIENT */;
/*!40101 SET CHARACTER_SET_RESULTS=@OLD_CHARACTER_SET_RESULTS */;
/*!40101 SET COLLATION_CONNECTION=@OLD_COLLATION_CONNECTION */;

```

References

https://drop4drop.org/water-crisis-malawi

https://wateraid.org/where-we-work/malawi

K. Ready, *International Conference on Signal Processing Communication, power and embedded system (SCOPES), 2016.*