SMART WATER QUALITY MONITORING SYSTEM

Mini Project Report submitted in partial fulfillment of the requirement for the degree of
B. E. (Information Technology)

Submitted By

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CERTIFICATE OF APPROVAL

For

Mini Project Report

This is to Certify that

Pratik Poojari

Sagar Patil

Have successfully carried out Mini Project entitled
"SMART WATER QUALITY MONITORING SYSTEM" in partial fulfillment of degree course in Information Technology
As laid down by University of Mumbai during the academic year 2021-2022

Under the Guidance of "Prof. Rasika Ransing"

Signature of Guide

Head of Department

Examiner 1

Examiner 2

Principal

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Abstract

Agriculture is the backbone of our country and it is very important to know the parameter of soil and water for efficient harvesting. The various parameters that can be monitored are Soil moisture, pH of water, Temperature, etc.

We previously measured these parameters in different tutorials but today we will not only combining them but also display them on a webpage so that they can be monitored from anywhere in the world.

Water monitoring is a crucial part of maintaining many environments including industrial buildings, commercial properties and healthcare establishments.

Technology has advanced to the extent that there are now highly sophisticated, accurate and convenient smart water monitoring systems which offer a whole host of benefits to property owners.

If sampling is the sole way that water quality Is checked, there is unfortunately always the prospect of human error. Results are open to interpretation and represent a snap shot in time, rather than a full picture of a number of days or weeks.

With advanced water monitoring technology, highly accurate measurements allow building managers, FMs and maintenance teams to detect and gather more data, including dissolved oxygen – a pre-cursor to all types of corrosion.

1. Introduction

Water pollution ensures when lethal materials move into water sources like ponds, rivers, lakes, seas and oceans, gets dissolved and suspends in water or gets deposited on the bed. Pollution will degrade the quality and purity of water. Ensuring pure and safer water is really challenging due to undue sources of chemicals and contaminants. Pollution of water can be instigated by numerous ways; one of the main reasons for pollution is industrial waste discharge and city sewage. Secondary sources of pollution are pollutants that enter the water from soils or from atmosphere via rain or from groundwater systems.

Usually, soils and groundwater comprises of residues of modern practices in agriculture and also indecorously disposed wastes from industries. The major pollutants of water include viruses, bacteria, fertilizers, parasites, pharmaceutical products, pesticides, nitrates, faecal waste, phosphates radioactive substances and plastics. These materials will not alter the colour of the water always, but they might be indiscernible contaminants.

Measuring different paramaters of soil and water for efficient harvesting using IoE. Modern smart water monitoring systems analyse data continually and instantly alert users to changes in the system, giving peace of mind and reducing the need for unreliable and expensive sampling.

Smart systems are also designed to be easy-to-use, allowing easy access of all the data in one place, accessible via any internet enabled device.

Without a smart water monitoring system, sampling is the main way water quality checks take place. The problem with sampling Is that results can take weeks to come back, by which time conditions may have changed.

Using real-time monitoring, instant data allows pre-cursors to potential issues (such as corrosion) to be flagged up and immediately be addressed before major issues occur. The ability to make real-time decisions during critical moments can be vital in preventing expensive repairs and breakdown.

Smart meters have already become an essential component of the modern-day electrical grids and are now finding their way in the water utilities. Currently, in a world where people are perishing due to lack of water, these meters are the breakthrough innovation that water utilities can use to provide everyone with potable water.

2. Aim and Objectives

Unlike traditional water gauges, smart water meters are a part of a wide area network that allow utilities and consumers to engage in two-way communication. These meters help water suppliers to enhance their water distribution network and incorporate robust water conservation & management practices.

In the operational, industrial and consumer vertical, these meters offer numerous benefits. Let us go through some of these advantages:

These IoE supports a two-way interaction between water distributors and end consumers. This means that the water supplier can monitor the consumption of individual houses that are connected to its network in real-time. Customers Identifying Consumption Inefficiencies Identifying consumption patterns and inefficiencies is another application of smart meters. Water utilities and suppliers generally lack clear transparency in their water conservation attempts. Reduction in Non-Revenue Water .The main causes that contribute to the non-revenue water are:

- Leaks
- Theft
- Meter inefficiencies
- Water main break

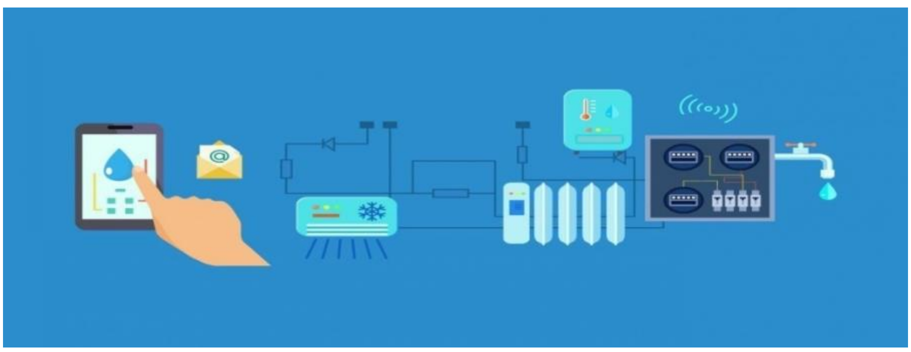


Figure2.1

3. Problem Statement

First of all, include all the header files, which will be required throughout the code. Here we are using **onwire h** and **DallasTemperature.h**library for a DS18B20 temperature sensor. This can be downloaded from the links given and included in the Arduino library. Similarly, we are using **ArduinoJson.h**library for sending JSON data from the transmitter to the receiver side.

1) Next, define the connection pin of Ar0duino, where the output pin of the DS18B20 sensor will be connected, which is digital pin 2 in my case. Then, objects for ***onewire*** class and ***DallasTemperature*** class are defined which will be required in the coding for temperature measurement.

2) Next, the calibration value is defined, which can be modified as required to get an accurate pH value of solutions.

3) Then a JSON Object is defined which will be required for sending parameters from the Transmitter part to the Receiver part.

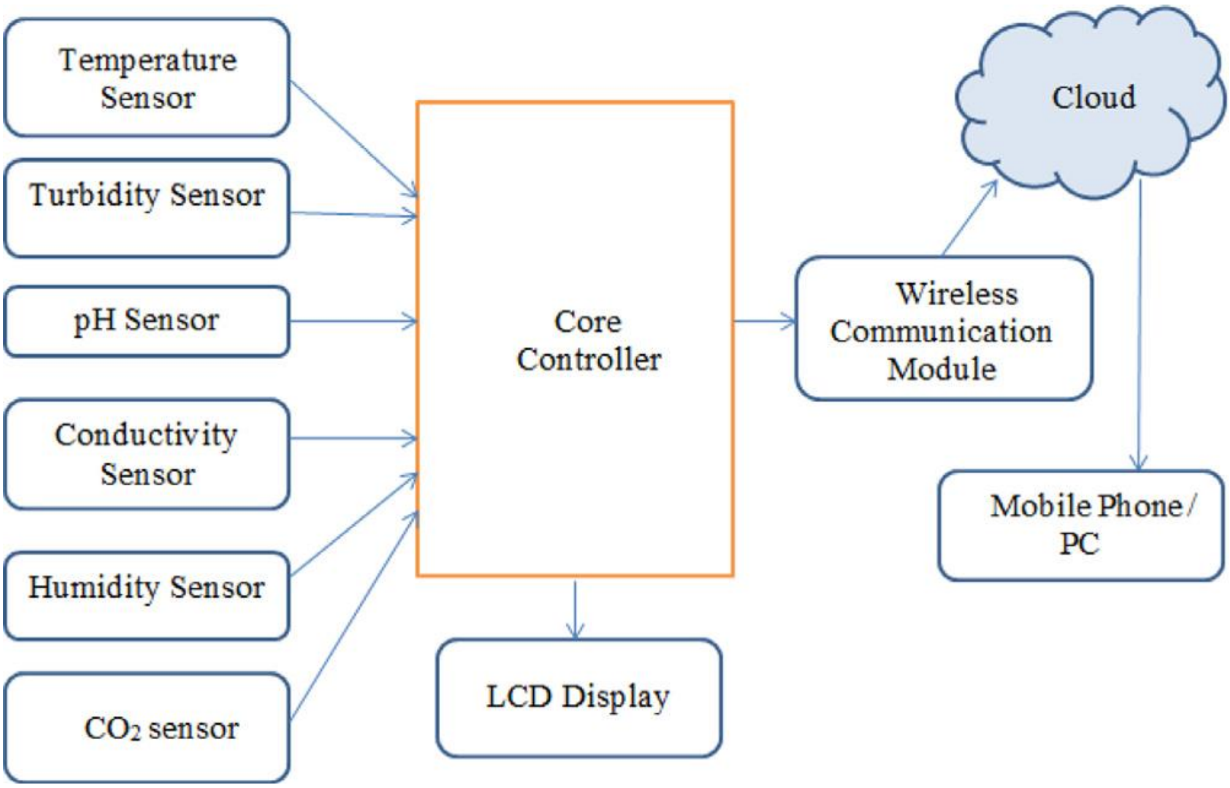
4) Inside ***loop(),***read 10 sample Analog values and store them in an array. This is required to smooth the output value.

5) Then, we have to sort the Analog values received in ascending order. This is required because we need to calculate the running average of samples in the later stage.

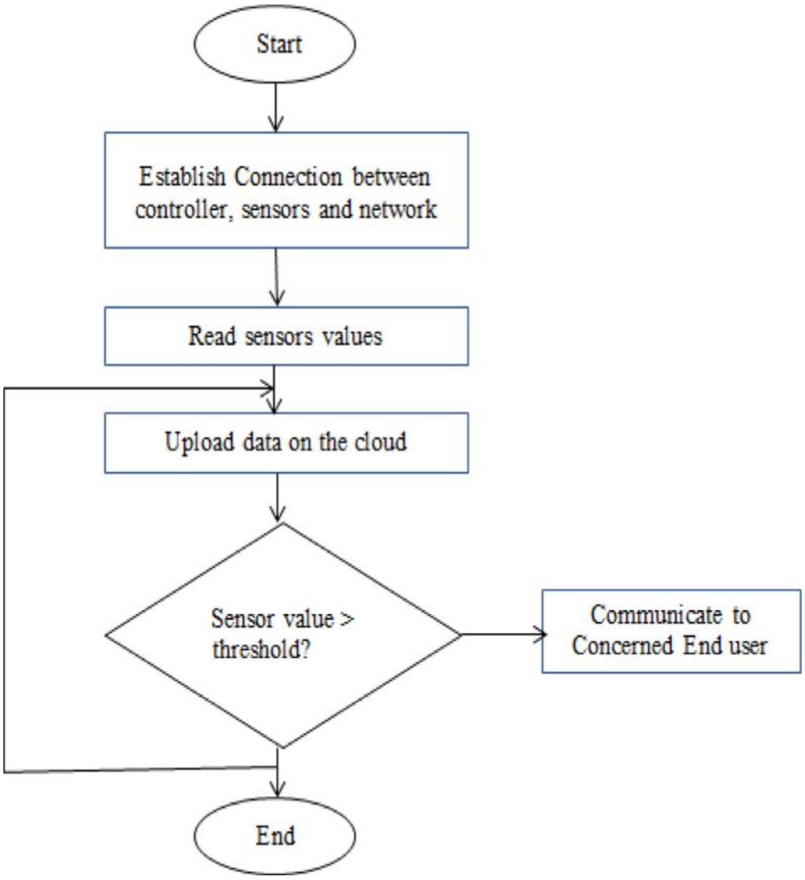
Finally, calculate the average of a 6 centre sample Analog values. Then this average value is converted into actual pH value and stored in a variable.
To send a command to get the temperature values from the sensor, ***requestTemperatures()*** function is used.

4. Proposed System

4.1 Block Diagram



4.2 Flow Chart (Working of the Model)



5. Components

5.1 Hardware:

5.1.1 NodeMCU

NodeMCU v3 is a development board which runs on the ESP8266 with the Espress if NonOS SDK, and hardware based on the ESP-12 module. The device features 4MB of flash memory, 80MHz of system clock, around 50k of usable RAM and an on chip WIFI Transceiver.

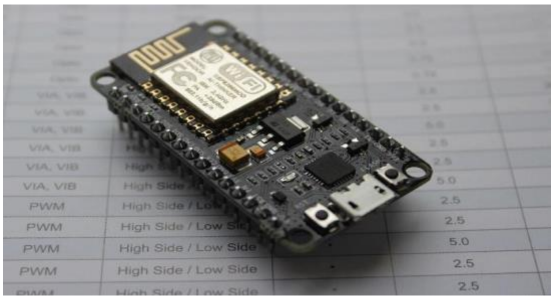


Figure 5.1.1A NODEMCU

Features:

Microcontroller: Tensilica 32-bit RISC CPU Xtensa LX106

Operating Voltage: 3.3V	Input Voltage: 7-12V
Digital I/O Pins (DIO): 16	Analog Input Pins (ADC): 1
UARTs: 1	SPIs: 1
Flash Memory: 4 MB	SRAM: 64 KB
Clock Speed: 80 Mhz	Wi-Fi: IEEE 802.11 b/g/n:

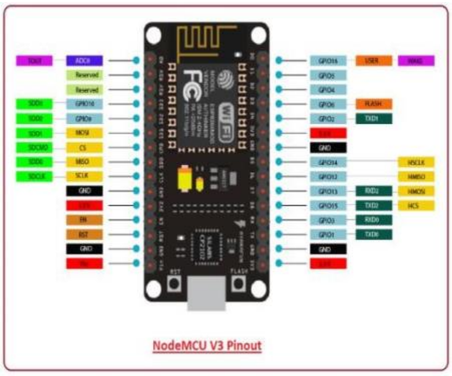


Figure 5.1.1B NodeMCU PIN Diagram

5.1.2 PH ELECTRODE-

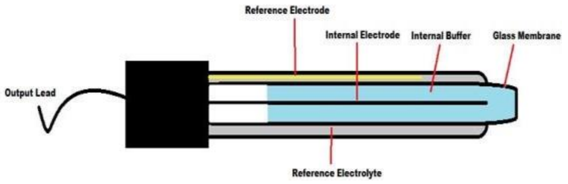


Figure 5.1.2

the construction of a pH sensor is shown above. The **pH Sensor** looks like a rod usually made of a glass material having a tip called “Glass membrane”. This membrane is filled with a buffer solution of known pH (typically pH = 7).

5.1.3 PH Signal Conversion Board:

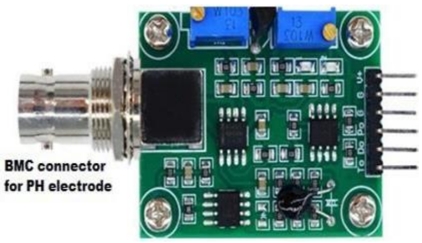


Figure 5.1.3

5.1.4 Temperature Sensor - DS18B20 is a single wire temperature sensor, as this can be interfaced with microcontroller or Arduino using single data wire. This is available in a waterproof and Non-waterproof format.

Technical Specifications:

- Temperature range: -55 to 125°C
- bit selectable resolution: 9-12 bit
- 1-Wire interface
- Unique 64-bit address enables multiplexing
- Accuracy: ±0.5°C

- Operating Voltage: 3-5 VDC
- Conversion time: 750ms at 12-biT

5.1.5 BreadBoard:

A breadboard is a solderless device for temporary prototype with electronics and test circuit designs .

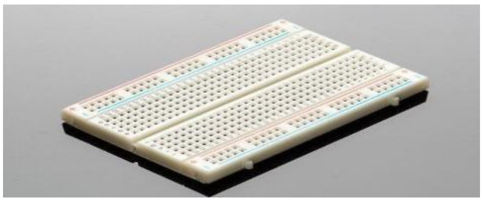


Figure 5.1.5 BreadBoard

5.1.6 Jumper Wire

Jumper wires are simply wires that have connector pins at each end, allowing them to be used to connect two points to each other without soldering.

Figure 5.1.6 Jumper Wire

5.1.7 Turbidity Sensor

Turbidity sensors measure the amount of light that is scattered by the suspended solids in water.

5.1.8Conductivity Sensor

When Contacting Sensors are used, the conductivity is measured by applying an alternating electrical current to the sensor electrodes (that together make up the cell constant) immersed in a solution and measuring the resulting voltage.

5.1.9 Humidity Sensor

The humidity sensor is a device that senses, measures, and reports the relative humidity (RH) of air or determines the amount of water vapor present in gas mixture (air) or pure gas.

5.1.10 CO_2 Sensor

CO_2 Sensors are used to measure the levels of carbon dioxide (CO_2). It is important to monitor this gas as it is an indicator of CO_2 emission levels, ventilation quality and combustion industrial processes.

5.2 Software

5.2.1 Arduino IDE

The Arduino integrated development environment (IDE) is a cross-platform application (for Windows, macOS,Linux) that is written in the programming language Java. It is used to write and upload programs to Arduino compatible boards, but also, with the help of 3rd party cores, other vendor development boards.

Figure 5.2.1 Arduino Ide

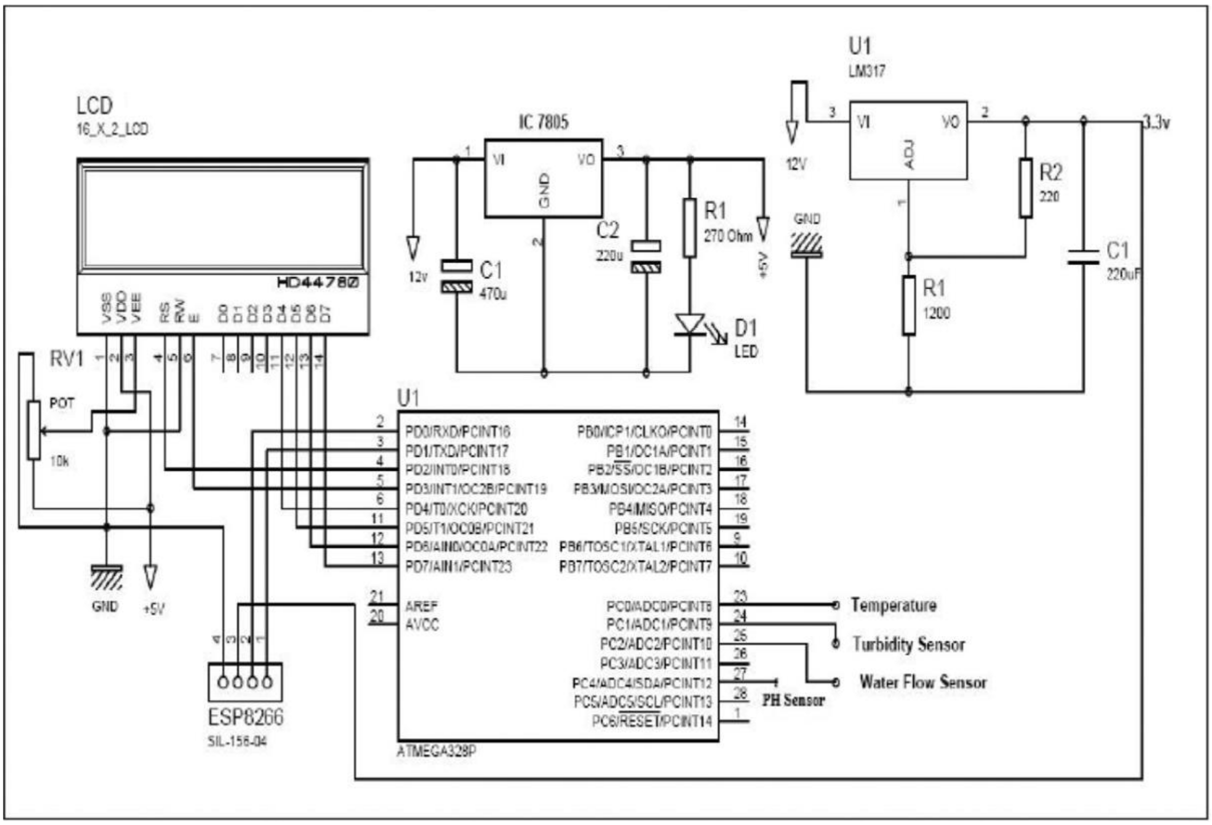
Blynk is a new platform that allows you to quickly build interfaces for controlling and monitoring your hardware.

5.2.2 Blynk App

IMPLEMENTATION

Figure 6.1 Circuit diagram

For Smart Water Quality Monitoring System is given below:



The schematic diagram of the proposed work is as shown in Figure6.1 . The work consists of two parts, the first one is hardware & second one is software. The hardware part has sensors which help to measure the real time values, another one is arduino ATMEGA328 converts the analog values to digital and LCD shows the displays output from sensors, Wi-Fi module gives the connection between hardware and software. AT- MEGA328 has inbuilt ADC and Wi-Fi modules. The water quality parameters are checked by one by one and updated in the cloud server as well as the values are displayed in the LCD display.

6.2

Arduino Programming:

First of all, include all the header files, which will be required throughout the code. Here we are using**onwire.h**and**DallasTemperature.h**library for a DS18B20 temperature sensor. This can be downloaded from the links given and included in the Arduino library. Similarly, we are using**ArduinoJson.h**library for sending JSON data from the transmitter to the receiver side.

```
#include <OneWire.h>
```

```
#include <DallasTemperature.h>

#include <ArduinoJson.h>
```

Next, define the connection pin of Arduino, where the output pin of the DS18B20 sensor will be connected, which is digital pin 2 in my case. Then, objects for ***onewire*** class and ***DallasTemperature*** class are defined which will be required in the coding for temperature measurement.

```
OneWire oneWire(2);
```

```
DallasTemperature temp_sensor(&oneWire);
```

Next, the calibration value is defined, which can be modified as required to get an accurate pH value of solutions.

```
float calibration_value = 21.34;
```

Then a JSON Object is defined which will be required for sending parameters from the Transmitter part to the Receiver part.

```
StaticJsonBuffer<1000> jsonBuffer;

JsonObject& root = jsonBuffer.createObject();
```

Inside ***loop(),***read 10 sample Analog values and store them in an array. This is required to smooth the output value.

```
for(int i=0;i<10;i++)

 {

 buffer_arr[i]=analogRead(A0);

delay(30);

 }
```

Then, we have to sort the Analog values received in ascending order. This is required because we need to calculate the running average of samples in the later stage.

```
 for(int i=0;i<9;i++)

 {

 for(int j=i+1;j<10;j++)

 {

 if(buffer_arr[i]>buffer_arr[j])
```

```
{
temp=buffer_arr[i];
buffer_arr[i]=buffer_arr[j];
buffer_arr[j]=temp;
}
```

```
}
}
```

Finally, calculate the average of a 6 centre sample Analog values. Then this average value is converted into actual pH value and stored in a variable.

```
for(int i=2;i<8;i++)
avgval+=buffer_arr[i]; float
volt=(float)avgval*5.0/1024/6; float
ph_act = -5.70 * volt +
calibration_value;
```

To send a command to get the sensor, temperature values from the ***requestTemperatures()*** function is used.

```
temp_sensor.requestTemperatures();
```

Now, analog values from the soil moisture sensor are read and this is mapped to percentage using ***map()*** function as shown below:

```
int moisture_analog=analogRead(A1); int
moist_act=map(moisture_analog,0,1023,1
00,0);
```

Finally, the parameters which are to be sent to NodeMCU, are inserted into JSON objects and they are sent via serial communication using ***root.printTo(Serial)*** command.

```
root["a1"] = ph_act; root["a2"] =
temp_sensor.getTempCByIndex(0);
root["a3"] = moist_act;
root.printTo(Serial);
Serial.println("");
```

7. Results & Discussion

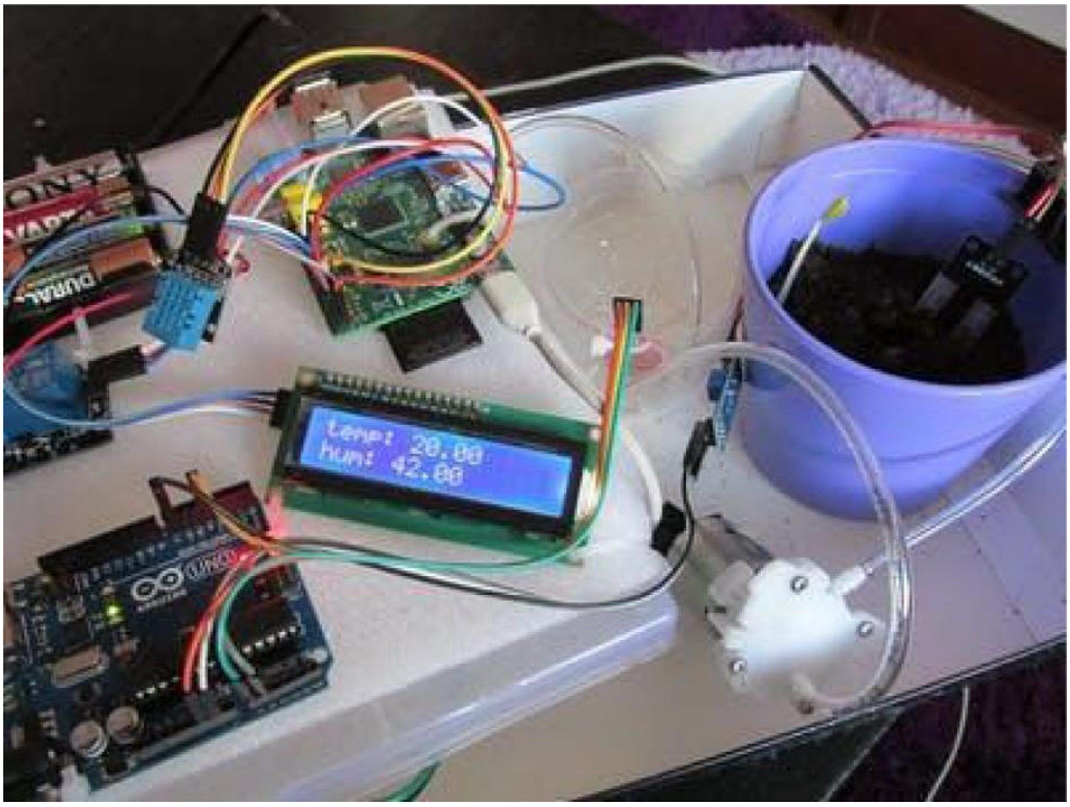


Figure 7.1 Apparatus with connection

In our project we have tried to simplify the need of common people regarding the knowledge about Smart Water Monitor .We made it easier for the consumers to get the basic knowledge regarding the System. Without a smart water monitoring system, sampling is the main way water quality checks take place.

The problem with sampling Is that results can take weeks to come back, by which time conditions may have changed. Using real-time monitoring, instant data allows pre-cursors to potential issues (such as corrosion) to be flagged up and immediately be addressed before major issues occur.

The ability to make real-time decisions during critical moments can be vital in preventing expensive repairs and breakdown.

The system proposed in this paper is an efficient, inexpensive IoE solution for real-time water quality monitoring. The developed system having Arduino Mega and NodeMCU target boards are interfaced with several sensors successfully. An efficient algorithm is developed in real-time, to track water quality.

If the above listed parameters are in the specified range, then the water is safe for drinking. If these parameters are out of specified range, then the water is not safe for drinking purpose.

Table 1 –

Table 1
Water quality parameter range for drinking water.

Parameter	Range
pH	6.5 to 8.5
Turbidity	< 5 NTU
ConductivityCarbon DioxideHumidity	200 to 800 µS/cm< 2.0 mg/L40% to 100%

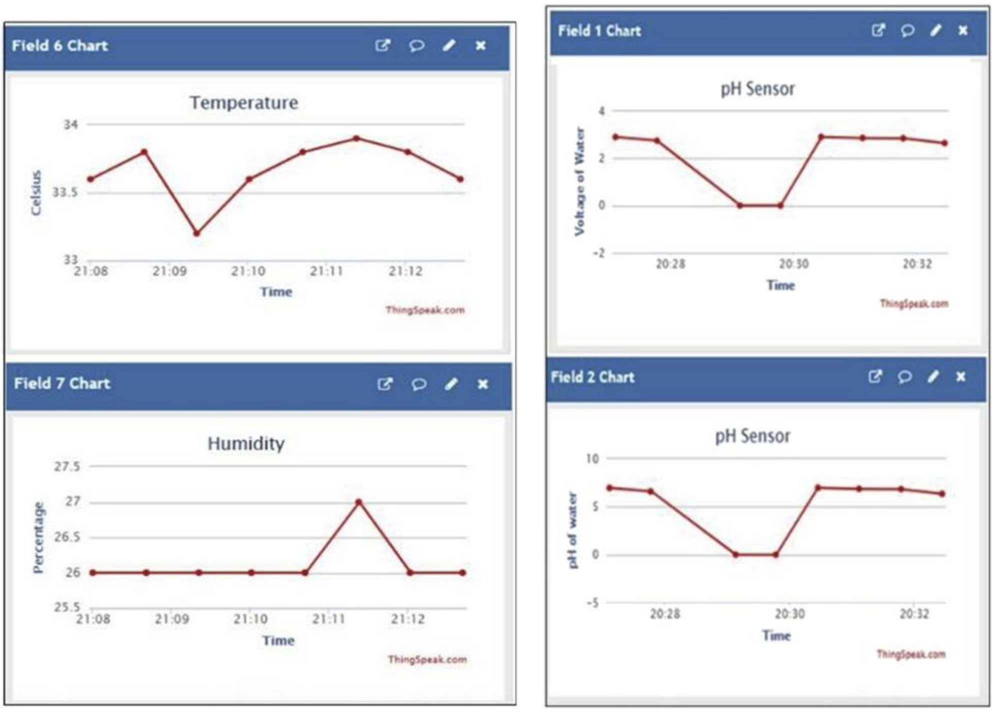
Table2 –

Water quality parameters for different samples.

Sample	Parameter	Measured Value
Water Sample 1	pH	7.5
	Turbidity	4 NTU
	Conductivity	450 µS/cm
	Carbon Dioxide	1.20 mg/L
	Humidity	42%
	Temperature	20° C
Water Sample 2	pH	9.3
	Turbidity	5.6 NTU
	Conductivity	600 µS/cm
	Carbon Dioxide	1.820 mg/L
	Humidity	60.44%
	Temperature	29.4° C
Water Sample 3	pH	9.72
	Turbidity	5.33 NTU
	Conductivity	709 µS/cm
	Carbon Dioxide	1.89 mg/L
	Humidity	64.67%
	Temperature	26.4° C

The developed model is tested with three different water samples and the results are tabulated in Table 2 . From the analysis, water sample 1 is drinkable and other two samples are not drinkable

Data Visualization Of The Results in Sensors



So this is how a smart water quality monitoring system can be built easily with few components.

8. Conclusion & Future Scope

Water Pollution is a major threat to any country, as it affects health, economy and spoils bio- diversity. In this work, causes and effects of water pollution is presented, as well as a comprehensive review of different methods of water quality monitoring and an efficient IoE based method for water quality monitoring has been discussed. Although there have been many excellent smart water quality monitoring systems, still the research area remains challenging.
This work presents a review of the recent works carried out by the researchers in order to make water quality monitoring systems smart, low powered and highly efficient such that monitoring will be continuous and alerts/notifications will be sent to the concerned authorities for further processing. The developed model is cost effective and simple to use (flexible). Three water samples are tested and based on the results, the water can be classified whether it is drinkable or not.
IoE Water Monitoring Systems: 4 Use Cases

1. Prevent Legionella with IOE flow monitoring.

2. Maintain a continuously healthy water supply with an IoE water quality monitoring system.

3. Detect and fix wasteful leaks with flow monitoring.

Every year,millions of gallons of water are wasted due to leakage, meter errors, and operational inefficiencies. Many facilities managers rely on regular inspections of the pipes to identify failures, but that could mean a leak isn't caught for several months after it begins. IoE water flow sensors can help identify leaks immediately by measuring the flow of water through a pipe and its rate of change. When sensor data shows a change in the normal rate, it could be an indicator of a pipe leakage or other operational malfunction, giving building managers a chance to address problems before too much water is wasted.

4. Achieve LEED and/or WELL certification. An increasing number of commercial buildings are pursuingLEEDand/orWELLcertification as part of their sustainability goals and healthy building initiatives.

References

1- S. Pasika, S.T. Gandla, Smart water quality monitoring system with cost-effective using IOE, Heliyon 6 (7) (2020), doi: 10.1016/j.heliyon.2020.e04096 .

2- [2] M. Mukta, S. Islam, S.D. Barman, A.W. Reza, M.S. Hossain Khan, "IOE based smart water quality monitoring system, in: Proceedings of the IEEE 4th International Con- ference on Computer and Communication Systems (ICCCS), 2019, pp. 669–673, doi: 10.1109/CCOMS.2019.8821742 .

3- [3] S. Konde, S. Deosarkar, IOE based water quality monitoring system, in: Proceedings of the 2nd International Conference on Communication & Information Processing (ICCIP), 2020 2020, doi: 10.2139/ssrn.3645467 .

4- https://www.irjet.net/archives/V5/i10/IRJET-V5I10219.pdf

5- K.A. Unnikrishna Menon, D. P., M.V. Ramesh, Wireless sensor network for river wa- ter quality monitoring in India, in: Proceedings of the Third International Conference on Computing, Communication and Networking Technologies (ICCCNT'12), 2012, pp. 1–7, doi: 10.1109/ICCCNT.2012.6512437 .

6- A.N. Prasad, K.A. Mamun, F.R. Islam, H. Haqva, Smart water quality monitor- ing system, in: Proceedings of the 2nd Asia-Pacific World Congress on Com- puter Science and Engineering (APWC on CSE), 2015, pp. 1–6, doi: 10.1109/AP- WCCSE.2015.7476234 .

7- A. Jerom B., R. Manimegalai, R. Manimegalai, An IOE based smart water qual- ity monitoring system using cloud, in: Proceedings of the International Conference on Emerging Trends in Information Technology and Engineering (ic-ETITE), 2020, pp. 1–7, doi: 10.1109/ic- ETITE47903.2020.450 . 2020doi: .