Water Parameter Monitoring on Cloud Using IOT Sensors

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Abstract: *Water pollution is one of the biggest fears for the green globalization. It has been an increasing problem over the last few years. In order to ensure the safe supply of the drinking water the quality needs to be monitor in real time. This paper presents a design and development of a low-cost system for real time monitoring of the water quality in IOT (internet of things). The objective of this water parameters monitoring system using internet of things is to find the quality of the water i.e. how the pH, turbidity and temperature content varies. The system consists of several sensors used to measuring physical parameters of the water. The parameters such as pH, turbidity, temperature of the water can be measured. The measured values from the sensors can be processed by the core controller. The Arduino model can be used as a core controller. Finally, the sensor data can be viewed on internet using WI-FI system. It also consists of an indication system which would tell us which test should be carried out on the water to make it safe for drinking. The purpose of this project is to make an easy-to-use water quality detector which can easily let us know various parameters of water and is the water safe for drinking.*

Keywords: WQM, Temperature, Wireless communication, Turbidity, Humidity, Ph, MCU, IoT.

1. INTRODUCTION

Water is very important to all form of life. In the 21st century, there were lots of inventions, but at the same time there is pollution. The increasing urbanization and industrialization has caused a serious public concern on growth of pollutants in water resources because of this there is no safe drinking water for the world's population. Nowadays, water quality monitoring in real time faces challenges because of global warming limited water resources, growing population, etc. The quality of water can be compromised by various tactors such as pollution, industrial waste, and natural contaminants. To ensure the preservation of this precious resource and protect human health, it is crucial to have an effective water quality monitoring system in place. Hence there is need of developing better methodologies to monitor the water quality parameters in real time.

Our research aims to implement a water prototype IOT based on a low cost board and different sensors and to design a system to be managed from mobile application, which will monitor the actual status of water sources. The proposed water quality monitoring system is consisting of a microcontroller and basic sensors, it is compact, low cost. The system detects the pH, turbidity and temperature of water continuous and the real-time data is send via wireless technology to the monitoring station.

1.1 Measured parameters

pH: The pH of solution is negative of the logarithm of the hydrogen ions activity:

$$pH = -\log (H+)$$

measuring pH of water provides reflection of acid -base balance. The pH balance of water can get affected by temperature; this must be taken into account. The pH of drinking water must have a value between 6.5 to 8.5.

TURBIDITY: Water turbidity is measure of amount of light spread by the matter in a liquid when a light shines through a water sample. The unit of turbidity is nephelometric turbidity unit (NTU) and the optimal drinking water is below 1 NTU.

TEMPERATURE: Water temperature is physical property expressing how hot or cold the water is. Temperature of water affects nearly every other water quality parameter.

2. LITERATURE SURVEY

Many methods are suggested by researchers for water quality monitoring. Previously, many work has been done on developing this system to ensure quality of water for drinking water.

In [1] authors IoT-based water quality monitoring systems, which leverage the Internet of Things (IoT) technology to monitor and assess the quality of water resources. IoT-based systems, including the selection and integration of sensors, data acquisition methods, communication protocols, and data analytics techniques. It explores the potential advantages of IoT in water quality monitoring, such as real-time monitoring, remote access, scalability, and cost-effectiveness.

In [2] the authors explore the application of artificial intelligence (AI) techniques in water quality monitoring. They provide a comprehensive and research studies that utilize AI for water quality assessment and prediction. The AI techniques employed in water quality monitoring, including machine learning algorithms, neural networks, support vector machines, and fuzzy logic. The authors delve into the potential of these techniques to analyze large datasets, identify patterns, and make accurate predictions regarding water quality parameters.

Another groundwater-quality mapping approach was described by Lawrence et al. for a small island area of the Philippines, using a neural network with the particle-swarm optimization method [3] .The implementation of various spatial interpolation methods results in significant variations from the true spatial distribution of water quality in a specific location. This research improves the mapping prediction capabilities of spatial interpolation algorithms. Current approach of project is water-quality monitoring system based on specific measured parameters.

[4] The feasibility of virtual sensing for water-quality assessment is reviewed. The review focuses on the overview of key water-quality parameters for a particular use case and the

development of the corresponding cost estimates for their monitoring. Current approach of project is focused on the water-quality monitoring system is based on low-cost components. .

[5] They discussed the design of a system that is efficient, cost-effective, can work in real-time. The main aim of the system is to find the drinking water is safe for health or not through water quality monitoring with the help of the Internet of Things. In this model microcontroller unit (MCU) is used to connect the required sensor for monitoring the nature of water and further processing is done in a web app. Thing-Speak platform is used for the analysis and visualization of data. The platform provides its server and cloud for storage of data and have lots of functionalities and graphically show the result through MATLAB programming and sent the data over the IoT.

[6] The project mainly focuses on local aquaculture species and allow the fish farmer to monitor the water quality and condition of fish. The system is build using Raspberry pi with different sensors for monitoring the relevant values for monitoring the water quality. The system is used for early detection as connected to the BLYNK cloud for sending and storage of data. The visualization of calculated data is done in the BLYNK platform, as it provides its server and cloud for storage, and notification is sent to the farmer when some changes occur like water.

3. PROPOSED METHODOLOGY

As shown in the block diagram the proposed system uses three sensors which are pH, turbidity, temperature sensor, and ESP32 which acts as a microcontroller unit i.e main processing module and also as a Wi-Fi module. This ESP32 process the information from the sensors and transfer the information on the online BLYNK platform. Among three sensors, two of the sensors collect the data in the form of analog signals; the MCU has an on-chip ADC that translates the sensor analog signals into the digital format for further study.

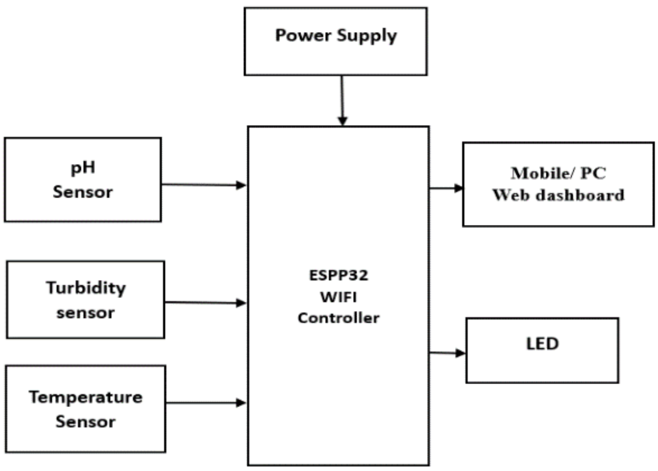

Figure 1. Block Diagram of Proposed System

So, to get this analog output from the sensor, the sensor's analog output of will be connected to the MCU's analog pins. Whereas the other one sensor output directly connected to the digital pins of the MCU units. All the sensors' data processed by the

MCU and updated to the Blynk App using the Wi-Fi data communication module to the central server. The system also consists of LEDs for indicating which purification process should be carried out in order to purify water. Three LEDs are used for three parameters, two LEDs are displayed on BLYNK platform and one is placed on hardware.

3.1 Sensors

3.1.1 **pH Sensor:** A pH sensor helps to measure the acidity or alkalinity of the water with a value between 0-14. When the pH value dips below seven, the water starts to become more acidic. Any number above seven equates to more alkaline. The pH of water can help determine the quality of water. Measuring the pH can also provide indications of pipe corrosion, solids accumulation, and other harmful by products of an industrial process.The Analog pH Sensor Kit is specially designed for Arduino controllers and has a built-in simple, convenient, and practical connection and features. It has an LED that works as the Power Indicator, a BNC connector, and a PH 2.0 sensor interface. To use it, just connect the pH sensor with the BNC connector, and plug the PH 2.0 interface into the analog input port of any microcontroller. If pre-programmed, you will get the pH value easily. Comes in a compact plastic box with foams for better mobile storage.

Figure 2. pH Sensor

3.1.2 **Turbidity Sensor:** Turbidity sensor detects water quality by measuring level of turbidity. It can detect suspended particles water by measuring the light transmittance and scattering rate which changes with the amount of total suspended solids (TSS) in water. This is a Turbidity Sensor with Module, an electronic monitoring module specially developed to work with microcontroller platforms. It is very efficient, the Turbidity Sensor can detect and verify the quality of the water, making the turbidity measurement, where it is possible to verify the results by means of digital or analog signal next to the corresponding pins in the accompanying electronic module.

Figure 3. Turbidity Sensor

3.1.3 Temperature Sensor: A temperature sensor is a device used to measure temperature. This is a 1-Meter-Long Waterproof, sealed and pre-wired digital temperature sensor probe based on DS18B20 sensor. It is very handy for when you need to measure something far away, or in wet conditions. Because they are digital, you don't get any signal degradation even over long distance. These 1-wire digital temperature sensors are fairly precise (±0.5°C over much of the range) and can give up to 12 bits of precision from the onboard digital-to-analog converter. They work great with any microcontroller using a single digital pin.

Figure 4. Temperature Sensor

The table below shows the standard value of water parameter.

Table 1. shows standard values of water parameters

Parameter	Quality Range	Units
pH	6.5-8.5	pH
Turbidity	1-5	NTU
Temperature	20	°C

3.2 ESP32 WIFI Controller

ESP32 is a series of low-cost, low-power system on a chip microcontrollers with integrated Wi-Fi and dual-mode Bluetooth. TheESP32 series employs either a Tensilica Xtensa LX6 microprocessor in both dual-core and single-core variations, Xtensa LX7 dual-core microprocessor or a single-core RISC-V microprocessor and includes built-in antenna switches, RF balun, power amplifier, low-noise receive amplifier, filters, and power-management modules. ESP32 is created and developed by Espressif Systems, a Shanghai-based Chinese company, and is manufactured by TSMC using their 40 nm process.[2] It is a successor to the ESP8266 microcontroller.

Figure 5. ESP32 WiFi Controller

3.3 Design Consideration

1. The system uses a ESP32 Microcontroller which acts as the main processing system for the WQM system.
2. Different Sensors such as pH, Turbidity, Temperature are used in order to sense the water parameters.
3. The system gets the supply when connected to the laptop.
4. Blynk IOT and Cloud platform is used for this purpose.
5. The Blynk platform with the help of gauge.

3.4 Description of the proposed design working

STEP 1: Initialize ESP32: The first step is to initialize the ESP32, for that purpose we power the ESP32 by connecting it to the laptop and feed the code in it. Appropriate connections are made as per the where we connect the three sensor,to the NodeMcu. The system first tries to connect with the wifi network mentioned in the code in order to establish a connection with the database as well as the Android app.

STEP 2: Sensors: The system incorporates various sensors to measure specific water quality parameters. Some commonly monitored parameters include pH, temperature, turbidity. These sensors may be built into probes that are directly submerged into the water.

STEP 3: Data Collection and Logging: The sensor readings are captured by data loggers or data acquisition systems. These devices collect and store the data over time, ensuring continuous monitoring.

STEP 4: Data Analysis and Visualization: The collected data is processed and analyzed using Blynk software.This analysis involves data validation, quality control checks, comparison against established water quality standards or regulatory guidelines. The analyzed data can be visualized through dashboards, allowing users to interpret and understand the water quality.

STEP 5: Alarms and Notifications: To ensure timely responses to any water quality issues or deviations from desired standards, the monitoring system include an LED notification on the dashboard system so that when certain parameters exceed predefined thresholds will let us know which parameter has exceeded. So that we can take precautionary measures to make the water safe for use.

4. FLOW CHART

The flowchart below shows working of the project.
As the power supply is given to ESP32 the system starts initializing the process the sensors begin to monitor the value of pH, Turbidity and Temperature. With the help of the ESP32 WIFI module the data will get displayed on Blynk App. Following figure shows flowchart of water parameter monitoring system.

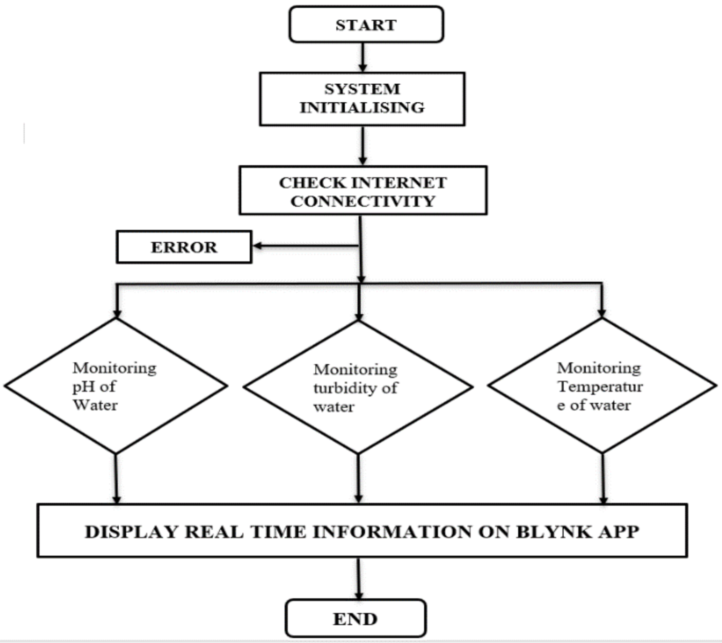

Figure 6. Flow chart of proposed system

5. RESULTS AND DISCUSSIONS

5.1 Results

We have identified a suitable implementation model that consists of different sensor devices and other modules.

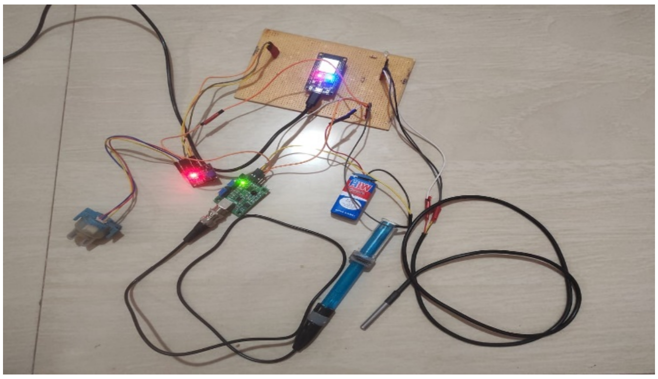

Figure 7. Hardware

Figure 8. Samples used for testing

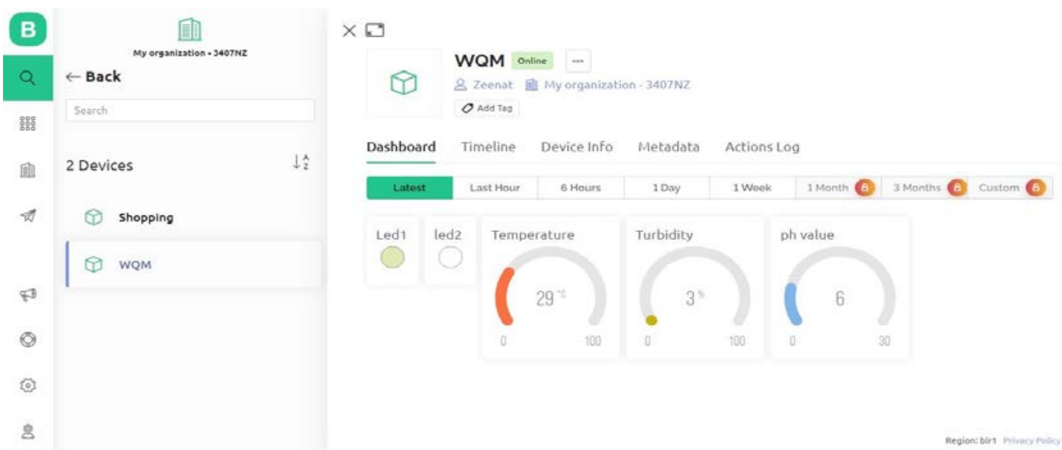

Figure 9. Blynk console result of drinking water

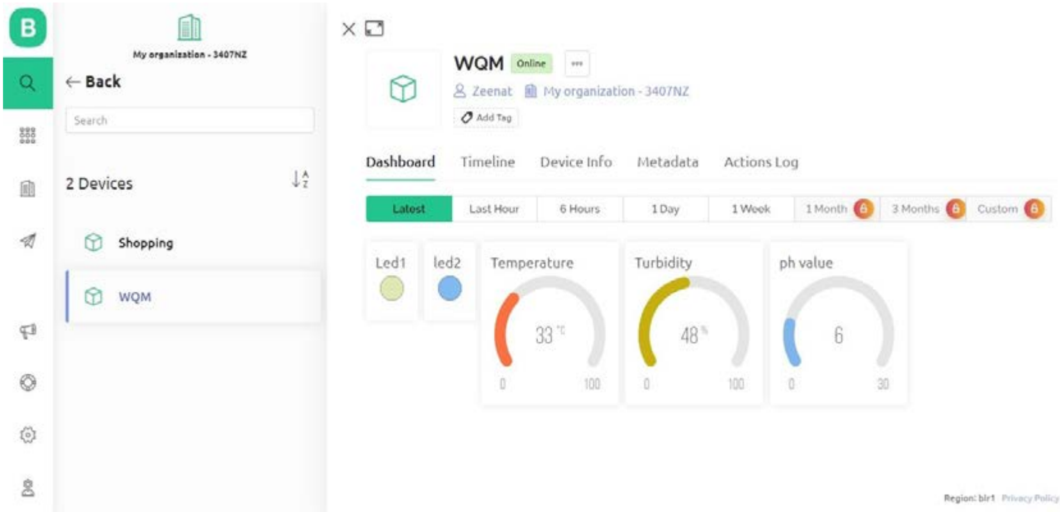

Figure 10. Blynk console result of Puddle water

5.2 Evaluation metrics

Below are the results obtained after testing different parameters on different water samples.

5.2.1 **pH Value:** The proposed work is evaluated by using different water samples. For pH, we used the samples of drinking water, detergent water, lime water and puddle water. The main evaluation parameter used to know whether the pH value is accurate or not. We used standard value of water pH recommended by the WHO.The response time for the result is 0.5-0.8 sec.Ph electrode build upto the quality level that gives an accuracy of approx. 0.1 pH.The threshold value for pH is between 0-14 PH.

Table 2. Results obtained for pH

Samples Used	PH value obtained	Actual value of ph
Drinking Water	7	6.5-8
Tap Water	7	7
Puddle Water	6	5.6-5.8
Detergent Water	9	10
Lime Water	11	12.4

5.2.2 **Temperature value:** The proposed work is evaluated by using different water samples. For temperature,we used the samples of drinking water, chilled water and warm water. The main evaluation parameter used to know whether the temperature value is accurate or not. We used standard value of water temperature recommended by the WHO.The threshold value for temperature ranges from 0°C-70°C.The accuracy of sensor is +/- 0.5°C. The response time for temperature is 750 milliseconds for 12 bit resolution.

Table 3. Results obtained for temperature

Samples Used	**Temp value obtained**	**Actual value of Temp**
Normal water	29°C	20°C
Chilled water	12°C	6-16°C
Warm water	38°C	40-45°C

5.2.3 Turbidity Value: The proposed work is evaluated by using different water samples. For turbidity,we used the samples of drinking water and puddle water. The main evaluation parameter used to know whether the turbidity value is accurate or not. We used standard value of water temperature recommended by the WHO.The threshold for turbidity is set between 1-100. The main evaluation parameter for the turbidity sensor is the intensity of light scattered at 90° as beam passes through water sample.

Table 4. Results obtained for turbidity

Samples Used	**Turbidity value obtained**	**Actual value of Turbidity**
Drinking Water	3 NTU	1-5 NTU
Puddle Water	48 NTU	50 NTU

6. CONCLUSIONS

Monitoring of Turbidity, Ph & Temperature of water makes use of water detection sensor with unique advantage and existing Wi-Fi network. The system can monitor water quality automatically, and it is low in cost and does not require people on duty. So, the water quality testing is likely to be more economical, convenient and fast. The system has good flexibility. Only by replacing the corresponding sensors and changing the relevant software programs, this system can be used to monitor other water quality parameters. The operation is simple. The system can be expanded to monitor hydrologic, air pollution, industrial and agricultural production and so on. It has widespread application and extension value. By keeping the embedded devices in the environment for monitoring enables self-protection (i.e., smart environment) to the environment. To implement this need to deploy the sensor devices in the environment for collecting the data and analysis. By deploying sensor devices in the environment, we can bring the environment into real life i.e., it can interact with other objects through the network. Then the collected data and analysis results will be available to the end user through the Wi-Fi.

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