Water Quality Monitoring System Based ON IOT

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***Abstract*—** For aquatic ecosystems to remain healthy and for drinking water to be safe for human consumption, water quality monitoring is essential. As IoT usage increases across more industries, it is now viable to develop water quality monitoring systems based on IoT technology. The IoT-based water quality monitoring system that is suggested in this research uses a variety of sensors to collect real-time data on water quality indicators like pH, temperature, dissolved oxygen, and turbidity. The system combines sensor data and sends it to a platform in the cloud for analysis and storage. The system also use machine learning algorithms to detect odd changes in water quality measures and notify the appropriate parties. Numerous advantages are offered, such as minimal cost, excellent scalability, and real-time monitoring capabilities.

Keywords—smart water quality monitoring, Remote sensing, Internet of Things.

I. Introduction

IoT-based systems for monitoring water quality are made to gather and process information about variables that affect water quality in real-time, including pH, temperature, dissolved oxygen, and turbidity. In order to continuously monitor water quality and deliver accurate and timely information to stakeholders, such as water management, environmental authorities, and the general public, this system relies on a network of sensors and communication devices.

Three primary parts make up the IoT-based water quality monitoring system: sensors, communication tools, and data management software. The sensors are in charge of detecting the variables affecting water quality, and the communication tools send the information to a centralized database for storage and analysis. The tools for data analysis and visualization are provided by the data management software, enabling stakeholders to make well-informed choices on the management of water quality.

The capacity to provide real-time data on water quality is one of the key benefits of an IoT-based water quality monitoring system. This makes it possible to identify problems with water quality early and take quick action to prevent future degradation. Additionally, the equipment is easily scalable up or down to accommodate various water management scenarios.

An Internet of Things (IoT)-based system for monitoring water quality can offer a workable and inexpensive solution in various circumstances, including lakes, rivers, and reservoirs. We can better safeguard our water resources and guarantee their sustainability for future generations if we have a better understanding of the factors that affect water quality.

II. BACKGROUND

IoT-based water quality monitoring systems are a cutting-edge technical option for managing and monitoring water resources. These systems gather, analyze, and transmit real-time data on water quality using a network of interconnected sensors, gadgets, and software.

The use of IoT in water quality monitoring systems allows for the remote monitoring and real-time analysis of indicators of water quality such pH, temperature, dissolved oxygen, turbidity, and conductivity. This enables early detection of water quality issues and prompt action to halt water contamination, ensuring a supply of safe and clean water.

IoT-based solutions for monitoring water quality also have a variety of benefits, such as improved data accuracy, cost savings, and effectiveness. Data from these systems can be used to build prediction models for regulating water quality, ensuring sustainable water usage and preventing diseases spread through water use.

In general, IoT-based water quality monitoring systems are essential for making sure that there is always access to clean, safe water for human consumption, industrial use, and agriculture.

III. INTERNET OF THINGS

By offering real-time data collection, analysis, and control of water quality indicators, the Internet of Things can play a crucial role in water quality monitoring systems. Water quality information can be gathered using IoT devices like sensors, metres, and data recorders for variables including pH, dissolved oxygen, temperature, conductivity, and turbidity.

Wireless networks can be used to transfer the collected data to a central server, where data analytics and machine learning algorithms can be used to analyse it and reveal trends and abnormalities in water quality. When any water quality metric deviates from the permissible range, the real-time data can also be used to send alerts and notifications.

As it enables ongoing monitoring and analysis of water quality parameters, the application of IoT in water quality monitoring systems can result in more efficient and effective monitoring and management of water resources. This can aid in the early discovery of problems with water quality, allowing prompt action to be taken to stop the quality of the water from further deteriorating.

As a result of real-time data collection, analysis, and control of water quality indicators, the Internet of Things can, in summary, play a crucial role in water quality monitoring systems, enabling better and more efficient management of water resources.

IV. APPROACH

Sensors are used in an IoT-based water quality monitoring system to gather information on variables including temperature, pH, dissolved oxygen, turbidity, and conductivity. These sensors are linked to a network of devices that uses microcontrollers, gateways, and cloud servers to gather, process, and archive the data.

The system may be set up to automatically send out messages when any water quality metric exceeds acceptable boundaries, enabling quick remedial action. Aquaculture, wastewater treatment, and drinking water monitoring are just a few of the uses for this technique.

The following are the essential steps in creating an IoT-based system for monitoring water quality:

1. Choose the metrics to keep an eye on: Determine the crucial variables that are crucial for the particular application.

2. Choose the right sensors: Decide which sensors can be incorporated into an IoT network and are capable of measuring the specified parameters.

3. IoT network design: To build an IoT network, decide on the network architecture and choose the relevant hardware, such as microcontrollers, gateways, and cloud servers.

4. Create software to gather and process data: Create software to gather and process the data gathered by the sensors.

5. Implement data reporting and visualization: Create a user interface that enables users to see data and produce reports.

6. Test the system, then make it available in the field to make sure it is operating as intended.

7. Maintain the system: To guarantee the system's continuing operation and the data's accuracy, regularly maintain and update it.

V. WATER PARAMETER

Water quality monitoring systems based on IoT (Internet of Things) typically measure several water parameters to provide comprehensive and real-time information on water quality. Some of the commonly measured parameters include:

1. pH: The pH scale measures how acidic or alkaline water is. It is a crucial metric to watch since it affects how easily heavy metals and nutrients dissolve in water and has a big effect on aquatic life.

2. Temperature: As it influences the speed of biological and chemical reactions in water, temperature is a crucial metric to monitor. Aquatic life might suffer from abrupt temperature fluctuations as well.

3. Dissolved oxygen: It is a gauge of how much oxygen is present in water. Given that it has an impact on aquatic creatures' survival, it is a crucial parameter to watch.

4. Turbidity: Water clarity is determined by the turbidity of the water. High turbidity levels can be an indication of suspended particulates, which can be harmful to aquatic life.

5. Conductivity: Water's conductivity is a metric for how well it can carry an electrical current. As it offers information on the total dissolved solids (TDS) in water, which can have a substantial impact on aquatic life, it is a crucial metric to monitor.

6. Total dissolved solids: TDS are a way to quantify how much dissolved matter there is in a given amount of water. Due to the potential harm that high TDS levels can do to aquatic life, it is crucial to monitor this parameter.
7. Chemical oxygen demand (COD): The phrase "chemical oxygen demand" refers to the quantity of oxygen required to oxidise both organic and inorganic molecules in water. Monitoring COD is essential since it can reveal the presence of pollutants in water at high amounts.
8. Biochemical Oxygen Demand: This is Known by the abbreviation BOD, this term describes the volume of oxygen needed by bacteria to decompose organic substances in water. It is a crucial indicator to watch since it shows how much organic pollution there is in the water.

9. Nitrate and Phosphate: These nutrients are crucial for the survival of aquatic life. High concentrations of these nutrients, however, can

cause eutrophication, which can harm aquatic life and water quality.

Typically, a microcontroller or microprocessor coupled to a number of sensors and probes is used to measure these characteristics. The microcontroller or microprocessor subsequently sends the data to a cloud-based server for analysis and monitoring.

VI. STRUCTURE

In general, a water quality monitoring system is made up of a variety of sensors, including pH, turbidity, temperature, conductivity, humidity, and many others. All of the sensors are wired to a central controller, which oversees operations, collects data from the sensors, compares it to standards, and then wirelessly transmits the results to the authorities or end users who need to know.

Additional elements that can be added to the IoT water quality monitoring system include actuators for controlling water quality parameters, alarms and notifications to notify users of problems, and a historical database of water quality data for trend analysis and decision-making.

Overall, the IoT-based water quality monitoring system offers a quick and easy way to keep track of water quality metrics in real-time, ensuring that water resources are safe for use by people and the environment.

With the development of IoT technology, the system for monitoring water quality is growing smarter, using less electricity, and being easier to use. Fig. 1 depicts the flowchart for the smart water quality monitoring system.

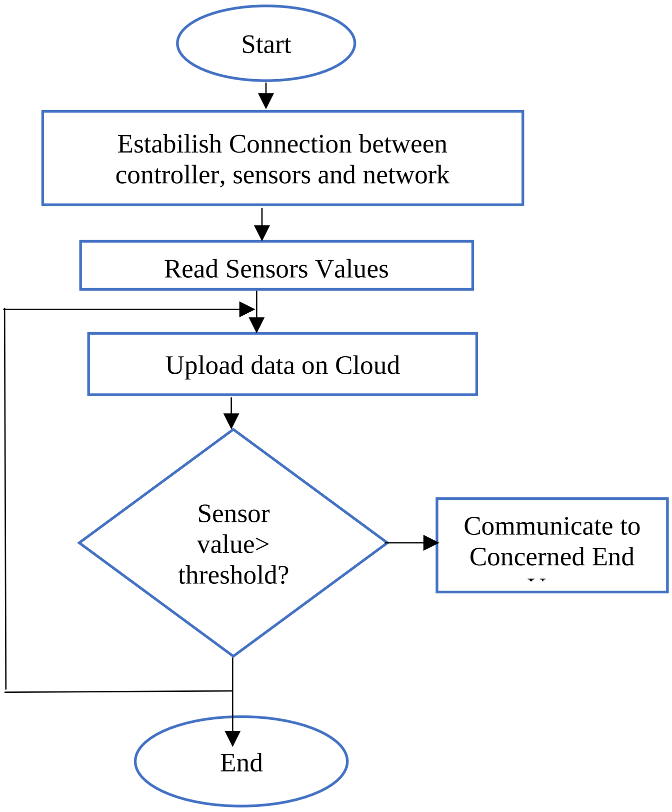

Fig.1Working functions of Water Quality Monitoring System.

The main controller incorporates a number of sensors, including a pH sensor, conductivity sensor, temperature sensor, turbidity sensor, and many others. The sensor leads are submerged in water for testing. Before being read by the core controller and transmitted to the cloud, the ADC will analyse the sensor values. By assessing whether or not the sensor value exceeds the threshold, the values will be continually tracked. The concerned end user will be informed if the sensor value exceeds the threshold so they may take appropriate action. When the sensor value falls below the threshold, the settings are reevaluated for another water source.

VII. SCHEMATIC ANALYSIS

The work is divided into two parts: first, the hardware, and then the software. The hardware and software are linked together through a Wi-Fi module. The gear comprises of sensors that aid in real-time measurement, an Arduino ATMEGA328 that transforms analogue values into digital, an LCD that displays sensor output, and an LCD that displays sensor data. There are ADC and Wi-Fi components in the ATMEGA328.

The LCD panel displays the values of each water quality parameter as they are analysed, updated on the cloud server, and shown one at a time.

VIII. DISCUSSION

The quality of the public water supply has drastically declined as a result of a shortage of resources for producing drinking water, high financial demands, an increase in population, the urbanisation of rural regions, and an excessive use of marine resources for salt extraction.. A smart water quality monitoring system is an essential tool for ongoing water quality analysis. Figure 2 depicts the water quality monitoring system's created model.

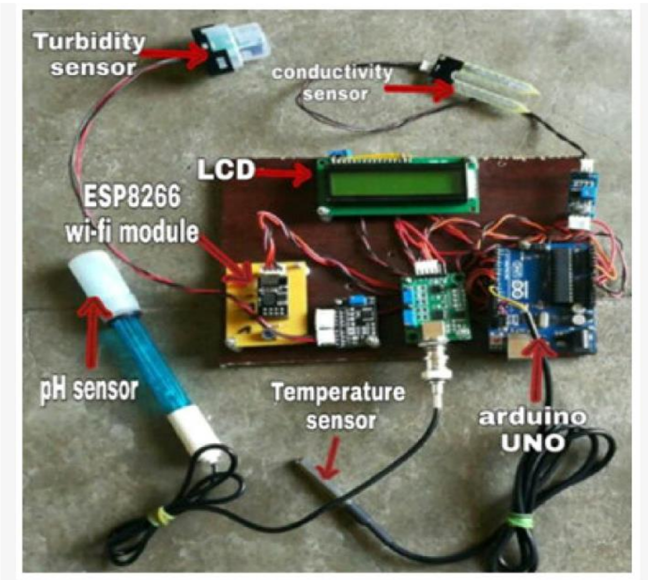

Fig.2 Model of the Water Quality Monitoring System

The model offers a number of distinct water quality requirements for safe drinking water in Table 1.

Table 1. Drinking water quality parameter range

Parameter	Range
pH	6.5 to 8.5
Turbidity	< 5 NTU
Conductivity	200 to 800 µS/cm
Carbon Dioxide	< 2.0 mg/L
Humidity	40% to 100%

If the mentioned parameters are within the acceptable range, the water is safe to drink. If any of these conditions are not met, the water is dangerous to drink.

The developed model is tested using three different water samples, and the outcomes are shown in Table 2.

Table 2. Metrics for water quality for several samples.

Sample	Parameter	Measured Value
1st Water Sample	pH	7.3
	Turbidity	3 NTU
	Conductivity	440 µS/cm
	Carbon Dioxide	1.30 mg/L
	Humidity	41%
	Temperature	18 deg C
2nd Water Sample	pH	8.3
	Turbidity	5.4 NTU
	Conductivity	580 µS/cm
	Carbon Dioxide	1.780 mg/L
	Humidity	58.44%
	Temperature	25.4 deg c
3rd Water Sample	pH	8.72
	Turbidity	4.77 NTU
	Conductivity	680 µS/cm
	Carbon Dioxide	1.75 mg/L
	Humidity	61.67%
	Temperature	24.6 deg C

According to the analysis, only water sample 1 is fit for consumption while the other two are not.

IX. CONCLUSION

This research has examined the causes and consequences of water contamination as well as a comprehensive assessment of many methods for measuring water quality. A successful IoT-based approach for monitoring water quality has also been researched. Even if there are many great smart solutions for monitoring water quality, the subject is still challenging.

In order to create intelligent, energy-efficient, and highly effective water quality monitoring systems that will enable continuous monitoring and the transmission of warnings and notifications to the necessary authorities for follow-up action, current research efforts have been reviewed in this paper. The developed model is versatile and cost-effective. It is feasible to decide whether or not the water is fit for ingestion after testing three different water samples.

Future systems for monitoring water quality and safeguarding water resources through prompt action should make use of cutting-edge sensors to detect a wide range of quality metrics, wireless communication standards to improve communication, and the Internet of Things.

X. DECLARATION

As a result, we, the authors of the paper titled "Water Quality Monitoring System based on IOT," declare that the work presented there is unique and that the conclusions drawn from the authors' study are presented there.

Additionally, we attest that the submitted work has not already been published elsewhere or is not currently being considered for publication elsewhere. This includes publications in journals, conferences, symposiums, or seminars. We also declare that the work is unique and does not violate anybody else's rights, including licences or copyrights. The authors hereby assign to Science Direct all associated copyrights.

XI. ACKNOWLEDGEMENT

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