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Water Sense: IOT-Based Water Quality Monitoring System

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ABSTRACT:

The increasing importance of water quality monitoring in ensuring safe and sustainable water resources has led to the development of innovative technologies. This paper presents an Internet of Things (IoT) based water quality monitoring system designed to address the challenges associated with traditional manual monitoring methods. The proposed system leverages IoT technologies to provide real-time monitoring and analysis of key water quality parameters, including temperature, pH, dissolved oxygen, turbidity, and conductivity.

The proposed IoT-based water quality monitoring system offers several advantages over traditional methods, including reduced manual effort, improved accuracy, and enhanced real-time monitoring capabilities. It enables early detection of water quality issues, leading to timely interventions to protect public health and optimize water resource management. The system has the potential to be implemented on a large scale, benefiting both urban and rural areas, and contributing to the overall sustainability of water resources.

Keywords: Internet of Things, pH sensor, Turbidity sensor, Temperature sensor, ESP32, WI-FI module

I. INTRODUCTION:

Water is a valuable natural resource bestowed upon mankind, and its quality plays a vital role in the health of humans and animals. The contamination of water can lead to various diseases, impacting the entire ecosystem's life cycle. Lakes, reservoirs, and canals are significant sources of drinking water, but due to the rapid growth of the population, these water resources have become polluted and contaminated. The pollutants in water encompass viruses, bacteria, fertilizers, parasites, pharmaceutical products, pesticides, nitrates, faecal waste, phosphates, radioactive substances, and plastics. To address this issue, the Central Pollution Control Board has established groups of observation points to monitor the purity and quality of water. Traditionally, water pollution monitoring involved manually collecting water samples from different locations and conducting rigorous laboratory testing. However, this method is time-consuming, lacks precision, and incurs high costs. Therefore, an alternative approach is needed to streamline the process of water quality detection and communication.

In response to this need, we have developed a solution that enables easy monitoring of water quality in vast water bodies. Our approach utilizes an IoT device consisting of a pH sensor, turbidity sensor, temperature sensor, and an ESP32 microcontroller. By connecting these sensors to the ESP32, we can measure five key qualitative parameters of water: pH level, temperature, and turbidity.

The challenge with water pollution monitoring lies in the manual effort required to navigate a boat through lakes or reservoirs each time to assess pollution levels across the entire water body. Our solution aims to simplify this process. By deploying our IoT device, we can remotely monitor water quality with ease.

The pH sensor measures the acidity or alkalinity of the water, providing insights into its chemical composition. The turbidity sensor detects the level of suspended particles and impurities, indicating the water's clarity. The temperature sensor measures the water's heat levels, which can impact its suitability for various purposes. The collected data from these sensors is transmitted wirelessly to a central monitoring system, where it can be analysed and interpreted in real-time. This enables swift identification of potential water pollution issues, facilitating prompt action and preventive measures. By automating the monitoring process and eliminating the need for manual intervention, our solution saves time, improves accuracy, and reduces costs associated with traditional water quality assessment methods. Moreover, the availability of real-time data empowers stakeholders to make informed decisions regarding water management and pollution control.

In conclusion, ensuring the purity and quality of water resources is crucial for the well-being of both humans and animals. By leveraging IoT technology and incorporating pH, turbidity, and temperature sensors into our solution, we have developed an efficient and cost-effective method for monitoring water quality in vast water bodies. This advancement in water pollution control will contribute to the preservation of ecosystems, safeguard public health, and promote sustainable water resource management.

II. LITERATURE SURVEY AND PROPOSED SYSTEM

A. Literature survey:

Several studies have explored the application of IoT in water quality monitoring systems, highlighting the potential of this technology to address the limitations of traditional methods. In a study by Zhang et al. (2018), an IoT-based water quality monitoring system was developed using wireless sensor networks. The system successfully provided real-time monitoring of parameters such as temperature, pH, and conductivity, improving the efficiency and accuracy of water quality assessment.

Another research conducted by Li et al. (2020) proposed a water quality monitoring system based on IoT and cloud computing. The system utilized a combination of wireless sensor networks and cloud-based data analysis to achieve real-time monitoring, data storage, and decision-making support. The study demonstrated the effectiveness of IoT technologies in enhancing water quality monitoring capabilities and enabling proactive management strategies.

Furthermore, the work of Wang et al. (2019) focused on the development of an IoT-enabled water quality monitoring system for rivers. The system integrated multiple sensor nodes to collect data on parameters such as dissolved oxygen, turbidity, and ammonia nitrogen. The collected data was transmitted wirelessly to a central server for real-time analysis and visualization, facilitating effective decision-making for river water quality management.

B. Proposed system:

Building upon the existing literature, our proposed system aims to design an IoT-based water quality monitoring system that overcomes the limitations of traditional methods and provides real-time monitoring, data analytics, and decision support.

The system consists of the following key components:

1. Sensor Nodes: High-accuracy sensors will be deployed at strategic locations within the water distribution network to measure key water quality parameters such as temperature, pH, dissolved oxygen, turbidity, and conductivity.

2. Communication Network: The sensor nodes will utilize low-power wide area network (LPWAN) technologies.

3. Central Server: The central server acts as a data hub, receiving, processing, and storing the collected data in a database.

4. Web-based Dashboard: A user-friendly web-based dashboard will be developed to provide real-time visual representations of the monitored water quality parameters.

5. Decision Support System: The proposed system will incorporate a decision support system that utilizes the analysed data to provide recommendations and alerts in case of water quality deterioration.

The proposed IoT-based water quality monitoring system offers numerous advantages over traditional methods. It provides real-time monitoring, enhances accuracy, reduces manual effort, and enables proactive detection of water quality issues. By facilitating early interventions and informed decision-making, the system contributes to the protection of public health and the sustainable management of water resources.

Overall, the proposed system aims to harness the power of IoT technologies to revolutionize water quality monitoring, enabling efficient and effective management of water resources in a rapidly changing world.

III. SYSTEM REQUIREMENTS AND COMPONENTS

A. System requirements

- Arduino application
- C and c ++ programming
- ESP32 (Wi-Fi Module)
- PH sensor
- Turbidity Sensor
- Temperature Sensor

B. Components:

PH Sensor:

A pH sensor is one of the most essential tools that's typically used for water measurements. This type of sensor can measure the amount of alkalinity and acidity in water and other solutions. When used correctly, pH sensors can ensure the safety and quality of a product and the processes that occur within a wastewater or manufacturing plant.

pH Sensor- The pH of a solution is the measure of the acidity or alkalinity of that solution. The pH scale is a logarithmic scale whose range is from 0-14. Values above 7 indicate a basic or alkaline solution and values below 7 would indicate an acidic solution. The pH value of neutral water is seven. It operates on 5V power supply and it is easy to interface with Arduino. The normal range of pH is 6 to 8.5. When the pH sensor is connected to the

Fig 1. PH Sensor

Arduino board, we must calibrate the sensor to get the correct value. To calibrate the sensor, first we need to take a pure drinkable water and dip the sensor in it. Now the sensor value needs to be seven or around seven, so if it is not then we have to adjust the value by rotating the pin on the Analog to Digital Converter of the sensor. The sensor usually gives analogue values to convert into digital values, we used the Analog to digital converter. After the successful calibration of the sensor, it will be able to take pH values of water more accurately.

Turbidity sensor:

Turbidity- Turbidity is a measure of the cloudiness of water. Turbidity has indicated the degree at which the water loses its transparency. It is considered as a good measure of the quality of water. To find the degree of light which is dispersed by the accumulation of solids in any water can be find out with the help of turbidity sensors. The more the turbidity level of water means more number of particles accumulated in water. So, turbidity sensor is useful to examine the water if any impure particles are present in water or not. It also can raise surface water temperatures above normal because suspended particles near the surface facilitate the absorption of heat from sunlight.

Fig 2. Turbidity sensor

DS18B20 Temperature Sensor

DS18B20 is a pre-wired and waterproofed version of the DS18B20 sensor. It is handy for use when you need to measure something far away, or in wet conditions. The Sensor can measure the temperature between -55 to 125 °C (-67 °F to +257 °F). The cable is jacketed in PVC. Check the datasheet here: DS18B20 Sensor Datasheet.

Since it is digital, there is no signal degradation even over long distances. These 1-wire digital temperature sensors are precise, i.e., ±0.5 °C over much of the range. It can give up to 12 bits of precision from the onboard digital-to-analogue converter. They work great with any microcontroller using a single digital pin.

Fig 3. Temperature Sensor

ESP32

ESP32 is a single chip 2.4 GHz Wi-Fi and Bluetooth combo chip designed with TSMC ultra-low power 40 nm technology. It is designed and optimized for the best power performance, RF performance, robustness, versatility, features, and reliability, for a wide variety of applications, and different power profiles.

Fig 4. ESP32

IV. SYSTEM DESIGN AND MODEL DESIGN

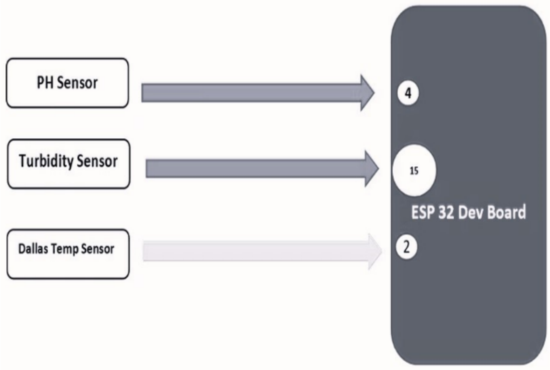

Fig 5. System Design

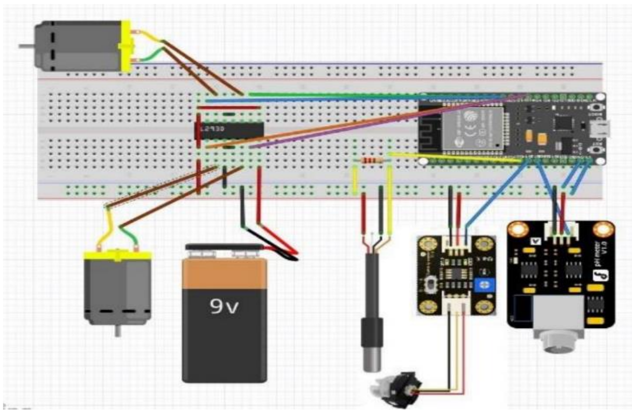

Fig 6. Model Design

V. METHODOLOGY:

To set up the ESP32 with Arduino IDE: Download and install Arduino IDE on your computer. Connect the ESP32 to the computer and select the appropriate port in the Arduino IDE. Write and compile the firmware using the Arduino IDE, which supports the Lua scripting language.

Connecting sensors to ESP32: Connect the pH, turbidity, and temperature sensors to different pins on the ESP32.Use jumper wires to establish connections between the sensors and the ESP32.Ensure that each sensor is connected to a separate pin to obtain values from different sensors.

Programming ESP32 with Arduino IDE: Open Arduino IDE and write the code to read values from the sensors. Compile the code and check for any errors. Upload the compiled code to the ESP32 using the Arduino IDE. Once the code is uploaded, the ESP32 can read values from the sensors.

Reading values from sensors: Immerse the sensors in water to measure the pH value, turbidity, and temperature. The sensors sense the water and provide the output to the ESP32.The ESP32 reads the values from the sensors to determine the water's pollution level.

Connecting ESP32 to the internet: the ESP32 has integrated Wi-Fi capabilities. Connect the ESP32 to the internet using Wi-Fi. Send the sensor readings to the Thing Speak cloud platform for analysis.

Displaying readings in an app: develop a mobile app using MIT App Inventor to receive the readings and analysis reports. Transfer the readings and analytical reports from the Thing Speak cloud to the app. The app will display the collected sensor values and readings to the user.

VI. RESULTS

the ESP32 is programmed using the Arduino IDE, sensors are connected to different pins on the ESP32, the Arduino IDE is used to write and upload the code, readings are obtained by immersing the sensors in water, the ESP32 sends the readings to the Thing Speak cloud platform, and a mobile app developed with MIT App Inventor displays the collected sensor values to the user.

VII. CONCLUSION

In conclusion, the IoT-based water quality monitoring system presents a promising solution for addressing the limitations of traditional methods in monitoring and managing water quality. By leveraging the power of IoT technologies, the system enables real-time monitoring, data analytics, and decision support, contributing to efficient water resource management and safeguarding public health.

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. This system could also be implemented in various industrial processes. The system can be modified according to the needs of the user and can be implemented along with lab view to monitor data on computers.

While further research and development are required to refine the system and adapt it to specific contexts, the IoT-based water quality monitoring system represents a significant advancement in the field of water quality management. It offers a valuable tool for monitoring, analysing, and managing water quality in a more efficient, cost-effective, and data-driven manner.

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