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Reconfigurable Smart Water Quality Monitoring System in IOT Environment

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Abstract: The quality of water refers to its suitability for different applications based on specific physical, chemical, and biological characteristics. Depending on its intended use, water may need to meet certain requirements, such as maximum levels of toxic substances for drinking water or specific temperature and pH ranges for supporting aquatic life. Therefore, water quality can be defined by various variables that limit water use. Balancing the demands of different users for quantity and quality often requires compromises when trying to improve or maintain a certain water quality.Preserving natural ecosystems is increasingly recognized as a crucial aspect of water quality management. These ecosystems are valuable for their intrinsic worth and also serve as sensitive indicators of changes or deterioration in overall water quality, providing useful additional information alongside physical, chemical, and other data.Wi-Fi is a wireless technology that uses radio frequency to transmit data through the air. With initial speeds of 1-2 Mbps, Wi-Fi transmits data in the frequency band of 2.4 GHz and uses frequency division multiplexing technology. Its range typically extends between 40-300 feet. In this project, a temperature sensor measures the water temperature, a pH sensor measures the pH level, and a turbidity sensor measures the amount of light scattered by suspended solids in the water. All three parameter values are continuously fed to a microcontroller and displayed on an LCD screen. If any value exceeds a preset threshold, a buzzer alerts the user. The microcontroller sends these measured values to the user's Android phone through a Wi-Fi module.

I. INTRODUCTION

The quality of water refers to its suitability for various uses and processes. The requirements for water quality may vary depending on the intended use, such as drinking, irrigation, or supporting aquatic life. Water quality is determined by various physical, chemical, and biological characteristics of water, and maintaining a certain level of quality can be challenging due to the competing demands of different users. In recent years, there has been growing recognition of the importance of natural ecosystems in managing water quality, as they are sensitive indicators of changes in overall water quality. On the other hand, Wi-Fi is a wireless technology that allows for data transmission using radio frequency. It operates in the frequency band of 2.4 GHz and has a range of 40-300 feet. Wi-Fi technology implements the concept of frequency division multiplexing technology, , and it has become a ubiquitous part of modern life. The use of sensors and microcontrollers can enhance the monitoring of water quality by measuring various parameters such as temperature, pH, and turbidity. The data collected from these sensors can be transmitted wirelessly to other devices, allowing for real-time monitoring and alerts when certain thresholds are exceeded.

II. LITERATURE SURVEY

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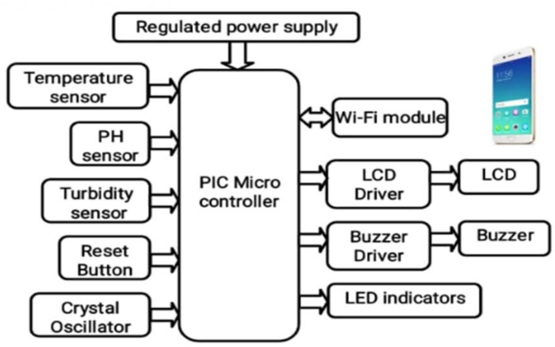
A. *Existing System*

Water pollution has become a critical issue in recent times, posing a threat to both human health and the environment. The existing methods for water quality monitoring are often costly and time-consuming, making it challenging to detect and respond to contamination quickly. Moreover, traditional methods are associated with several limitations, including low precision, complicated procedures, and long waiting times for results. As a result, there is an urgent need for advanced and efficient technologies to monitor water quality in real-time and mitigate the risks of water pollution.

B. *Proposed System*

the proposed system for the water quality monitoring project using IoT involves the use of sensors for temperature, pH, and turbidity measurements. These sensors are connected to a microcontroller that collects data and sends it to an Android phone through a Wi-Fi module. The data is also displayed on an LCD screen and an alarm is triggered if the threshold values for any of the parameters are exceeded. Compared to the existing systems, the proposed system has several advantages. Firstly, it provides real-time data on the water quality parameters, enabling prompt action to be taken in case of any discrepancies. Secondly, it is a cost-effective solution that is easy to install and maintain. Thirdly, the system is highly accurate and reliable, which is important for ensuring the safety of water for human consumption and other uses. Finally, the use of IoT technology allows for remote monitoring of water quality, making it possible to monitor water quality in remote and inaccessible areas.

Block diagram



III. IMPLEMENTATION

Implementing a water quality monitoring system using sensor technology and wireless communication can improve the accuracy and timeliness of water quality monitoring, leading to better management of water resources. The use of wireless technology enables the monitoring of water quality over a wider range and can provide data from multiple sensors simultaneously, allowing for a comprehensive analysis of water quality. The integration of natural ecosystems in managing water quality further enhances the sustainability of water resources.

A. *Temperature Sensor*

To measure the temperature of the water, a temperature sensor is used. The sensor is connected to the microcontroller, and the temperature data is constantly fed to the microcontroller. The temperature sensor measures the temperature in Celsius or Fahrenheit, and the data is displayed on the LCD screen. If the temperature exceeds a threshold value, the buzzer beeps, and the microcontroller sends an alert to the user's Android phone via Wi-Fi.

B. *PH Sensor*

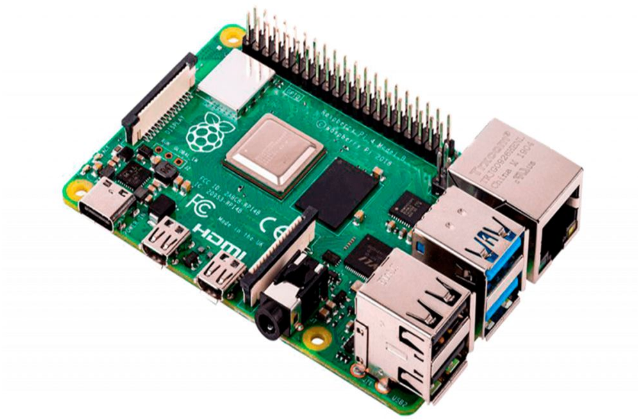
To measure the PH of water, a PH sensor is used. The sensor is connected to the microcontroller, and the PH data is constantly fed to the microcontroller. If the PH value exceeds a threshold value, the buzzer beeps, and the microcontroller sends an alert to the user's Android phone via Wi-Fi.

C. Turbidity Sensor
To measure the turbidity of water, a turbidity sensor is used. This sensor calculates the amount of light that is scattered by the suspended solids present in the water. The turbidity data is constantly fed to the microcontroller, and the turbidity value is displayed on the LCD screen. If the turbidity value exceeds a threshold value, the buzzer beeps, and the microcontroller sends an alert to the user's Android phone via Wi-Fi.

D. Microcontroller
A microcontroller, such as Arduino or Raspberry Pi, is used to control the sensors and display the data on the LCD screen. The microcontroller is programmed to read the sensor data and check whether it exceeds the threshold value. If the threshold value is exceeded, the buzzer beeps, and the microcontroller sends an alert to the user's Android phone via Wi-Fi. The microcontroller can also be programmed to store the data on an SD card for future analysis.

E. Wi-Fi Module
A Wi-Fi module is used to transmit the data from the microcontroller to the user's Android phone. The Wi-Fi module is connected to the microcontroller and can transmit data wirelessly over a range of 40-300 feet. The Wi-Fi module can be programmed to send alerts to the user's phone if any of the measured parameters exceed the threshold value.

IV. MICROCONTROLLER



A. Overview
The microcontroller is responsible for constantly monitoring the data received from the sensors, comparing it to the threshold values, and triggering alerts when necessary. If any of the parameters, such as temperature, PH, or turbidity, exceed the preset threshold values, the microcontroller activates a buzzer to alert the user, and sends an alert to the user's Android phone via the Wi-Fi module.
The microcontroller can be programmed using a variety of programming languages, including C and Python. It is also highly customizable, allowing for the integration of additional sensors or modifications to the system as needed.
Overall, the microcontroller is an essential component of the water quality monitoring system, enabling the collection and analysis of data on various water parameters and facilitating real-time monitoring and alerts.

B. LCD
The microcontroller receives data from the temperature, pH, and turbidity sensors, processes it, and displays the values on the LCD screen. The LCD screen is an easy-to-read visual display that allows the user to quickly and easily monitor the current status of the water quality parameters being measured.
If any of the measured values exceed the preset threshold limits, the microcontroller triggers an alarm and the LCD screen displays an alert message, notifying the user of the abnormality in the water quality.

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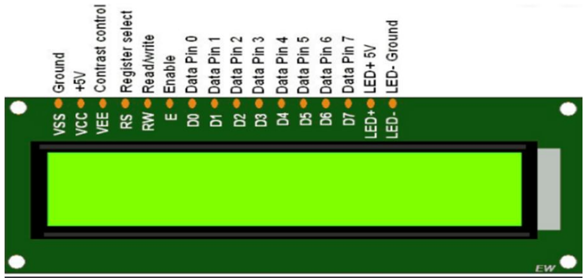
The use of an LCD screen in the water quality monitoring system enables the user to easily and quickly monitor the status of the water quality parameters being measured. It allows for real-time monitoring and alerts, and facilitates the collection and analysis of data on various water parameters. Overall, the use of an LCD screen is an essential component of the water quality monitoring system, allowing for easy monitoring and detection of abnormal values in the measured parameters.



V. SOFTWARE TOOLS

A. PIC-C compiler for Embedded C programming.

PIC-C is a compiler used for programming Microchip PIC microcontrollers in embedded C. It has libraries and debugging tools for easy development and generates optimized code for better performance. It helps developers create code that interacts with the hardware of the embedded system.

B. PIC kit 2.

PICkit 2 is a programmer used for loading or dumping code into Microchip PIC microcontrollers. It is a cost-effective solution for programming and debugging PIC microcontrollers, supporting a range of devices and interfaces. It allows developers to easily program their PIC microcontrollers, making it an essential tool for embedded system development.

C. Express SCH for Circuit design.

Express SCH is a software tool used for designing electronic circuits. It provides a user-friendly interface and a comprehensive set of features for designing schematics, including a library of electronic components, customizable templates, and automatic wiring. Express SCH allows users to quickly design and test electronic circuits, and can generate a bill of materials and PCB layouts. It is a popular tool for electronic design automation, used by engineers and hobbyists alike.

D. Proteus for hardware simulator.

Proteus is a software tool used for simulating electronic circuits and developing embedded systems. It is a powerful tool that includes a wide range of virtual components and can simulate the behavior of real-world hardware. Proteus is commonly used for testing and debugging embedded systems before they are built, as well as for simulating complex circuits that may be difficult or expensive to prototype in hardware. In the above project, Proteus was likely used to simulate the behavior of the microcontroller and sensors, allowing the developers to test their code and circuit design before building a physical prototype.

E. Advantages

1) Improved water quality monitoring: The project provides an automated system for monitoring important water quality parameters such as temperature, pH, and turbidity. This can help to detect changes in water quality more quickly and accurately, allowing for timely intervention and improved management of water resources.
2) Real-time data collection: The system collects and displays data in real-time, providing instant feedback on water quality conditions. This can help to identify potential issues before they become critical, allowing for proactive management of water resources
3) Module that allows data to be transmitted to a user's smartphone or computer. This means that water quality can be monitored remotely, which is particularly useful for hard-to-reach or remote locations.
4) Low-cost Solution: The project uses low-cost components such as the PIC microcontroller and sensors, making it an affordable solution for water quality monitoring. This means that the project can be easily replicated and scaled up, making it suitable for a range of applications.

F. *Disadvantages*

1) Reliance on Wi-Fi connectivity: The project relies on a Wi-Fi module to transmit data to a user's smartphone or computer. This means that a reliable Wi-Fi connection is required for the system to function properly. In areas with poor connectivity, data transmission may be delayed or interrupted.
2) Limited scalability: The project is designed as a small-scale monitoring system and may not be easily scalable for large-scale applications without significant modifications to the hardware and software.

G. *Applications*

1) Water quality monitoring in small-scale water systems such as residential or commercial buildings, aquariums, and aquaponic systems.
2) Monitoring of water quality in natural bodies of water such as lakes, rivers, and streams to assess the health of the ecosystem and detect potential pollution.
3) Water quality monitoring in agricultural settings to assess the health of soil and crops, and to detect potential contamination from fertilizers and pesticides.
4) Use in educational settings to teach students about water quality monitoring and its importance in environmental and public health.

VI. CONCLUSION

In conclusion, the water quality monitoring system developed in this project provides a simple and effective solution for monitoring key water quality parameters such as temperature, pH, and turbidity. The use of a microcontroller, LCD display, and Wi-Fi module allows for real-time monitoring of water quality parameters and easy transmission of data to a user's smartphone or computer. While the project has some potential limitations in terms of scope, accuracy, and scalability, it has several potential applications in various settings such as residential and commercial buildings, natural bodies of water, industrial processes, agricultural settings, and educational institutions. Overall, this project highlights the importance of water quality monitoring in maintaining a healthy environment and protecting public health.

A. *Future Aspects*

The water quality monitoring system developed in this project has several potential areas for future development and improvement. Some of the future scope for this project includes:

Integration of additional sensors to measure other water quality parameters such as dissolved oxygen, conductivity, and total dissolved solids.

Use of machine learning algorithms to detect patterns in water quality data and identify potential issues before they become significant problems.

Integration with smart irrigation systems to optimize water usage in agricultural settings and reduce waste.

An easy-to-use mobile application will be developed to provide access to real-time water quality data and alerts. The application will be integrated with cloud-based platforms for data storage and analysis, enabling large-scale monitoring and analysis across multiple locations. This integration will allow for more efficient and effective management of water resources.

Implementation of automated maintenance and calibration protocols to ensure accurate and reliable sensor readings.

Use of the system for long-term water quality monitoring to track changes over time and assess the effectiveness of management strategies. Overall, the water quality monitoring system has significant potential for future development and can help address the growing need for effective water quality management and monitoring.

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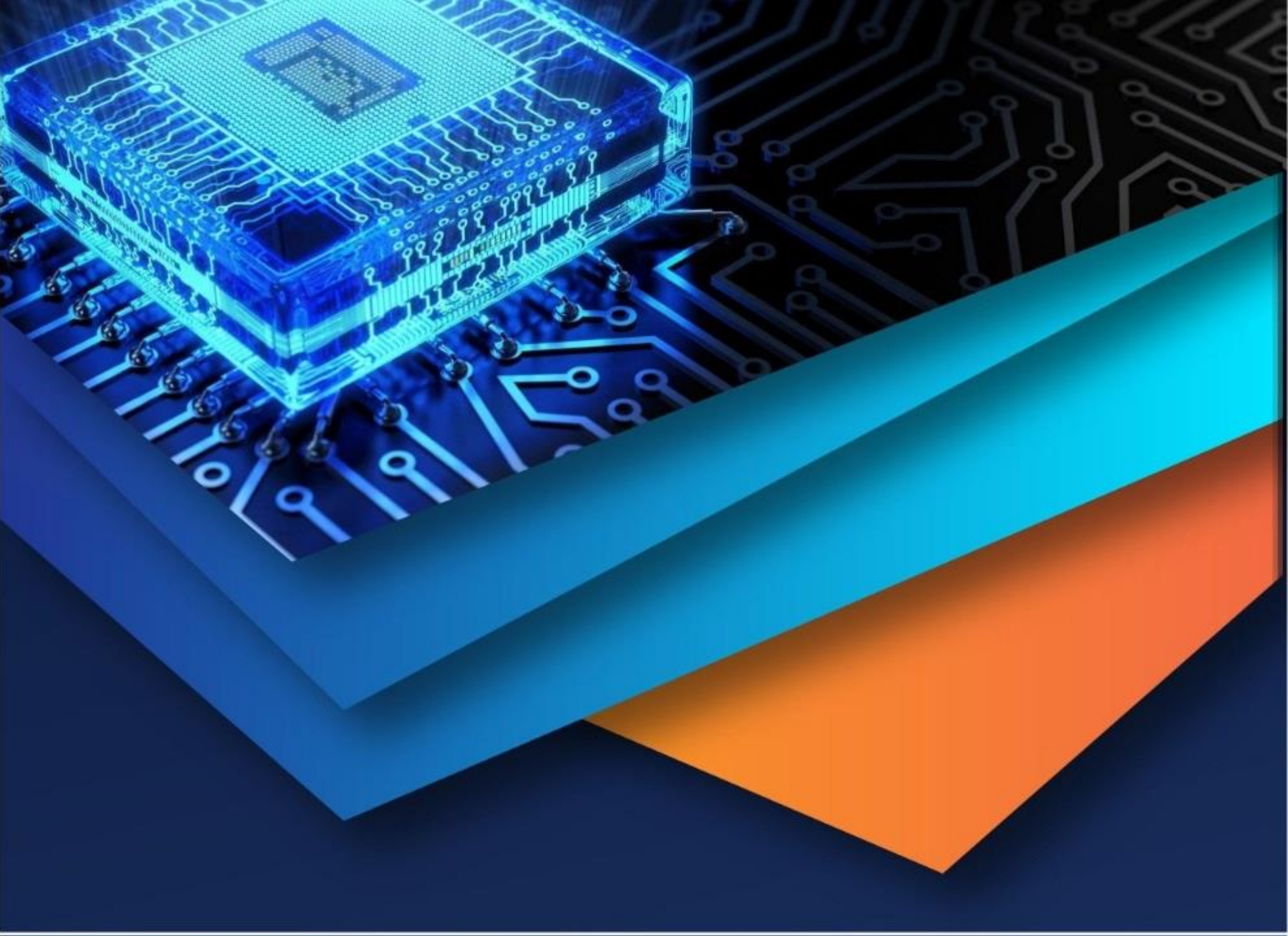

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