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Water Quality Monitoring System Based on IOT

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ABSTRACT

This initiative tackles the pressing issue of water contamination within the broader context of global environmental challenges. It proposes an affordable, real-time water quality monitoring system powered by Internet of Things (IoT) technology. The system utilizes a network of sensors to monitor critical physical and chemical characteristics, including temperature, pH levels, turbidity, and water flow. An Arduino microcontroller acts as the central processing unit, integrating and analyzing the data from the sensors. This information is then transmitted over Wi-Fi to a cloud-based platform, enabling remote access and analysis. The system's architecture demonstrates its potential to protect water resources, foster environmental sustainability, and promote economic development—particularly in rural communities. By utilizing sensors for turbidity, pH, and TDS, the system effectively evaluates water potability. Continuous monitoring is made possible by transmitting data from various water sources, including wells, lakes, and rivers, to an integrated development environment (IDE) and subsequently to a cloud server. This project highlights the significance of real-time data for informed decision-making in water resource management.

Keywords: The Internet of Things, or IoT monitoring of water quality, Sustainability of the environment, public health, real-time Temperature, conductivity, turbidity, pH, and sensors Wireless User interface, cloud platform, data processing, data analysis, and data storage pollution of water, management of water resources, safety and
Public health economical.

1. INTRODUCTION

The 21st century has seen many technical breakthroughs, but environmental problems like pollution and global warming have also gotten worse. The absence of clean drinking water is a significant consequence of these challenges. Factors such as a growing population, limited water resources, and climate change pose substantial obstacles to effective real-time water quality monitoring. Therefore, it is essential to develop sophisticated methods for the real-time assessment of water quality. One crucial parameter in this context is pH, which measures the concentration of hydrogen ions to ascertain whether water is acidic or alkaline. Pure water is characterized by a neutral pH of 7; Alkalinity is indicated by numbers above 7, whereas acidity is indicated by values below 7. For safe drinking water, the recommended pH range is between 6.5 and 8.5. Another significant factor is turbidity, which measures the concentration of suspended particles in the water. Lower turbidity levels are indicative of cleaner water, whereas higher turbidity increases the likelihood of waterborne diseases, such as cholera and diarrhea. While flow sensors gauge the water's flow velocity, temperature sensors aid in determining the water's thermal condition. Conventional techniques for monitoring water quality depend on the laborious and ineffective hand collecting of samples from multiple sites. The format of this document is as follows: Section II examines relevant work, The suggested system and its modules are introduced in Section III, followed by an explanation of how schematic circuit audits operate in Section IV, a discussion of the findings in Section V, and a conclusion outlining future research directions in Section VI.

2. METHODOLOGY

This article provides an in-depth illustration of a water quality monitoring system that utilizes IoT and machine learning technologies, specifically designed for rural regions. The proposed solution integrates both software and hardware components. In this case, an ESP32 microcontroller and various sensors were used to collect water samples from wells and ponds in Richana village, Solan, for real-time analysis. The system measured key water quality parameters, such as turbidity and pH levels, with the results being validated using a machine learning model built from Kaggle data. The collected data underwent processing through various machine learning methods, specifically Support Vector Machine (SVM), Random Forest (RF), and an Ensemble approach that incorporates Extreme Gradient Boosting The water's fitness for consumption was classified based on its pH and turbidity levels, which are critical indicators of water quality. Sensors for Total Dissolved Solids (TDS) and turbidity were used in conjunction with the ESP32 microcontroller to collect real-time data, which was then cross-checked against a Kaggle-derived model. The models were built using machine learning algorithms, focusing on the relationship between the TDS, turbidity, and water suitability for human consumption. To gather data, the TDS and turbidity sensors were immersed in the water, while the ESP32 microcontroller recorded the measurements. Initially, the data was presented on the Arduino IDE before being transmitted to the ThingSpeak Cloud server for additional analysis. Graphical representations were generated to assess whether the data exhibited linear or variable patterns, and machine learning algorithms were utilized to analyze the information. This study employed both Random Forest (RF) and Support Vector Machine (SVM) techniques. Furthermore, Extreme Gradient Boosting was applied to integrate these methods, providing precise predictions regarding the safety of water for human consumption. The Extreme Gradient Boosting model, which combines SVM and RF, was trained on a dataset that included water quality indicators such as TDS and turbidity, along with their respective water quality classifications. This methodology demonstrates greater efficacy in managing nonlinear relationships between input variables and output labels, as it is less susceptible to overfitting compared to other tree-based models. The system also utilizes an Arduino device, controlled by a laptop application, to automate the process. The project follows a defined timeline, which was established using a project flowchart, enabling structured development and implementation of the monitoring system. The steps are listed in the process chart below:

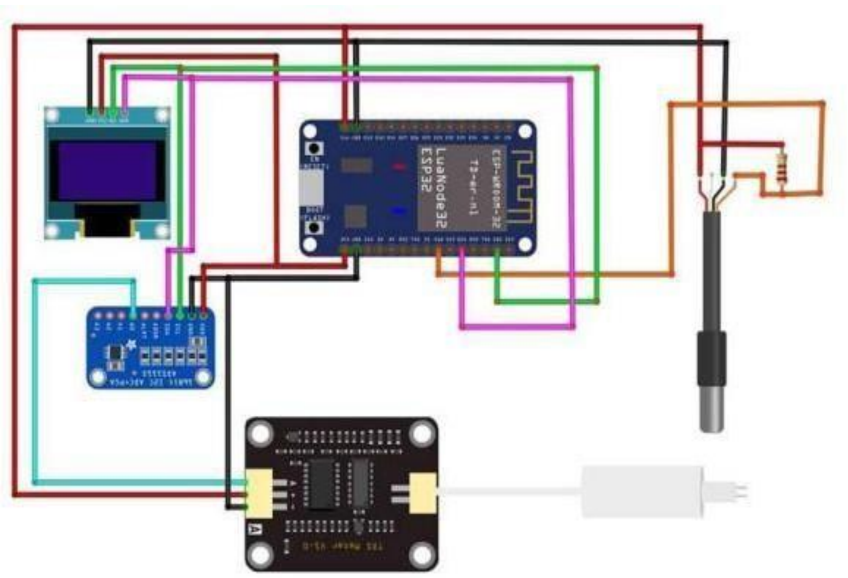
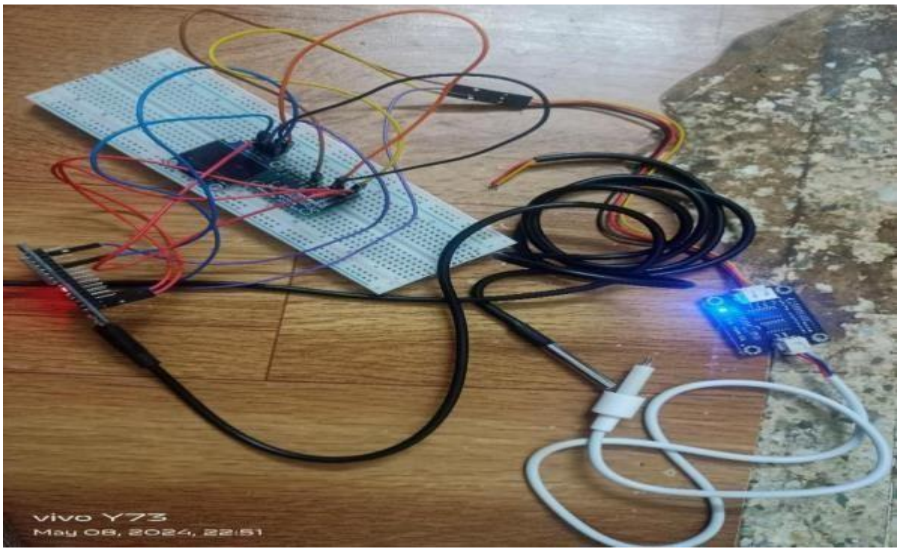


Fig.1. Diagram of the System Circuit

3. CONSTRUCTION OF CIRCUIT



- Connect the VCC (power) and GND (ground) pins of the TDS sensor to the Vin and GND pins of the ESP32, respectively, ensuring the sensor receives power and a stable ground connection.
- Next, link the ADS1115 ADC module to the ESP32 using the I2C communication protocol, connecting GPIO 22 (SCL) and GPIO 21 (SDA) for clock and data transfer.
- Attach the analog output pin of the TDS sensor to the A0 input pin of the ADS1115. Similarly, connect the output of the DS18B20 temperature sensor to GPIO18 on the ESP32.
- For display purposes, connect the OLED screen to the ESP32's I2C ports.
- Finally, power the OLED display by connecting its VCC and GND pins to the 3.3V and GND pins of the ADS1115. This setup allows you to use the TDS and temperature sensors, the ADC module, and the OLED display to monitor and visualize water quality measurements.

4. OUTCOME AND CONVERSATION

Our proposed methodology seeks to effectively assess water potability, which indicates the safety of water for human consumption, through the examination of critical parameters including turbidity, pH, and total dissolved solids (TDS). This initiative presents a novel concept that combines the Internet of Things (IoT) with artificial intelligence. The machine learning model utilized in this framework verifies the TDS, pH, and turbidity measurements through the use of various sensors and microcontrollers. Looking ahead, our model has the potential to be enhanced to include a broader spectrum of water quality indicators, such as temperature, pH, and dissolved oxygen, by incorporating additional sensors for a more thorough analysis. The water quality monitoring system utilizing IoT technology holds significant potential to transform water management, especially in regions that are lacking adequate resources. Its real-time, cost-effective, and cloud-based solution provides a practical and scalable means of ensuring safe drinking water. While there are challenges regarding sensor maintenance and data transmission, the benefits, including improved decision-making and better environmental protection, outweigh these obstacles. The future integration of additional sensors and AI capabilities could further enhance its effectiveness in ensuring the sustainability of water resources.

The system accurately measured pH, turbidity, and TDS, with real-time data collection and cloud transmission for remote monitoring. Alerts notified users when water quality exceeded safe limits, enabling quick action. The ESP32 microcontroller ensured energy efficiency for long-term, battery-powered use in remote areas.

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