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Water Quality Monitoring System Based on IoT

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Abstract*: Water quality is a crucial factor in public health, agriculture, and industry, and it has become increasingly important to monitor and maintain it effectively. Traditional water quality testing methods are often time-consuming, require manual sampling, and can involve complex equipment and processes, which may not be suitable for continuous monitoring. This project, titled "IoT- Based Water Quality Monitoring System," aims to create a real-time, automated solution that continuously monitors essential water quality parameters, namely pH, Total Dissolved Solids (TDS), and turbidity, using IoT technology. The system utilizes a suite of sensors connected to an ESP32 microcontroller to capture data for each of these parameters. The pH sensor monitors acidity or alkalinity, the TDS sensor measures the total amount of dissolved solids to determine purity, and the turbidity sensor assesses the clarity of water, detecting particulate matter that may indicate contamination.The gathered data is displayed locally on a 16x2 LCD screen, providing instant access to real-time readings. Additionally, the ESP32 microcontroller is connected to the Blynk cloud platform, where data is transmitted and stored, enabling remote access and monitoring of water quality. Users can access the data from any location via the Blynk mobile application, making it highly versatile and accessible. By using the Blynk cloud, the system provides valuable flexibility for applications in remote or unattended environments, where it may not be practical to monitor water quality manually.The IoT-based water quality monitoring system holds significant potential for application across a range of sectors. In drinking water supply systems, it allows for continuous monitoring, which helps maintain safety standards by identifying variations in water quality immediately. For agricultural irrigation, the system ensures that crops receive water that meets quality standards, contributing to better crop health and yield. Industrial applications, where specific water standards are often required for processes, can also benefit from the system's ability to detect deviations in water quality.In conclusion, this IoT-enabled water quality monitoring system provides an efficient, real-time, and remotely accessible solution for monitoring water parameters. With the integration of IoT, it presents a cost-effective approach to water management, enhancing responsiveness to quality changes and contributing to health and environmental sustainability. This system not only reduces the reliance on periodic manual testing but also enables proactive water quality management, thus supporting the sustainability of natural resources in a variety of applications.*

Keywords: pH sensor, Turbidity sensor, Temperature sensor, Esp32WI-FI module

I. INTRODUCTION

Water is a fundamental resource essential to human health, agriculture, and industrial processes. Maintaining its quality is vital to prevent health risks and ensure sustainable development. As urbanization and industrial activities increase, water sources are subjected to pollution from chemicals, waste, and other contaminants, making water quality monitoring a critical task. Conventional water quality monitoring methods rely heavily on manual sampling and laboratory analysis, which are labor-intensive, time-consuming, and often limited by frequency and geographic reach. To address these challenges, advancements in Internet of Things (IoT) technology offer an innovative approach, enabling continuous and automated monitoring of water quality parameters in real-time.

This project, "IoT-Based Water Quality Monitoring System," aims to leverage IoT technology to create an efficient, real-time monitoring solution. Using key sensors to measure pH, Total Dissolved Solids (TDS), and turbidity, the system captures essential water quality indicators. Each parameter provides valuable insight: the pH level indicates water's acidity or alkalinity, critical for safe drinking water and agricultural use; the TDS value reveals the concentration of dissolved solids, influencing water purity; and turbidity indicates water clarity, with higher turbidity potentially signaling the presence of contaminants or particulate matter. By continuously tracking these metrics, the system can promptly detect any deviations from standard quality thresholds, allowing for rapid response to prevent adverse effects.
The system architecture integrates these sensors with an ESP32 microcontroller, which processes the sensor data and transmits it to the Blynk cloud server for remote access. Locally, a 16x2 LCD display provides real-time readings, making the information readily accessible to users on-site. Through the Blynk platform, users can view the collected data remotely via a mobile application, allowing them to monitor water quality from anywhere with internet access. The Blynk platform also supports additional functionalities like data storage, alerts, and notifications, which can be configured to provide warnings when water quality parameters fall outside acceptable ranges.
This IoT-based system brings multiple advantages over traditional monitoring approaches. It reduces the need for manual sampling and testing, thereby minimizing human error and operational costs. It also offers continuous data collection, making it possible to observe trends and patterns over time, which aids in more informed decision-making for water resource management. Furthermore, the ability to monitor water quality remotely supports applications in remote or difficult-to-access locations, such as rural water supplies, agricultural fields, and industrial sites, where frequent on-site testing may not be feasible.In summary, this project introduces an IoT- enabled solution to water quality monitoring, addressing the limitations of conventional methods. By automating data collection, providing real-time visibility, and offering remote access to water quality information, this system enhances water management practices, contributing to public health, environmental sustainability, and industrial efficiency

II. LITERATURE SURVEY

Nikhil Kedia entitled "Water Quality Monitoring for Rural Areas-A Sensor Cloud Based Economical Project." Published in 2015 1st International Conference on Next Generation Computing Technologies (NGCT-2015) Dehradun, India. This paper highlights theentire water quality monitoring methods, sensors, embedded design, and information dissipation procedure, role of government, network operator and villagers in ensuring proper information dissipation. It also explores the Sensor Cloud domain. While automatically improving the water quality is not feasible at this point, efficient use of technology and economic practices can help improve water quality and awareness among people.[1] Jayti Bhatt,Jignesh Patoliya entitled "Real Time Water Quality Monitoring System".This paper describes to ensure the safe supply of drinking water the quality should be monitored in real time for that purpose new approach IOT (Internet of Things) based water quality monitoring has been proposed. In this paper, we present the design of IOT based water quality monitoring system that monitor the quality of water in real time. This system consists some sensors which measure the water quality parameter such as pH, turbidity, conductivity, dissolved oxygen, temperature. The measured values from the sensors are processed by microcontroller and this processed values are transmitted remotely to the core controller that is raspberry pi using Zigbee protocol. Finally, sensors data can view on internet browser application using cloud computing.[2] Michal Lom, Ondrej Pribyl, Miroslav Svitek entitled "Industry 4.0 as a Part of Smart Cities". This paper describes the conjunction of the Smart City Initiative and the concept of Industry 4.0. The term smart city has been a phenomenon of the last years, which is very inflected especially since 2008 when the world was hit by the financial crisis. The main reasons for the emergence of the Smart City Initiative are to create a sustainable model for cities and preserve quality of life of their citizens. The topic of the smart city Water Quality Monitoring System Based on IOT 1109 cannot be seen only as a technical discipline, but different economic, humanitarian or legal aspects must be involved as well. In the concept of Industry 4.0, the Internet of Things (IoT) shall be used for the development of so–called smart products. Subcomponents of the product are equipped with their own intelligence. Added intelligence is used both during the manufacturing of a product as well as during subsequent handling, up to continuous monitoring of the product lifecycle (smart processes). Other important aspects of the Industry 4.0 are Internet of Services (IoS), which includes especially intelligent transport and logistics (smart mobility, smart logistics), as well as Internet of Energy (IoE), which determines how the natural resources are used in proper way (electricity, water, oil, etc.). IoT, IoS, IoP and

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IoE can be considered as an element that can create a connection of the Smart City Initiative and Industry 4.0 – Industry 4.0 can be seen as a part of smart cities.[3] Zhanwei Sun,Chi Harold Li,Chatschik Bisdikian,Joel W.Branch and Bo Yang entitled "QOI-Aware Energy Management in Internet-of-Things Sensory Environments". In this paper an efficient energy management frame work to provide satisfactory QOI experience in IOT sensory environments is studied. Contrary to past efforts, it is transparent and compatible to lower protocols in use, and preserving energy-efficiency in the long run without sacrificing any attained QOI levels. Specifically, the new concept of QOI-aware "sensor-to-task relevancy" to explicitly consider the sensing capabilities offered by an sensor to the IOT sensory environments, and QOI requirements required by a task. A novel concept of the "critical covering set" of any given task in selecting the sensors to service a task over time. Energy management decision is made dynamically at runtime, as the optimum for long-term traffic statistics under the constraint of the service delay. Finally, an extensive case study based on utilizing the sensor networks to perform water level monitoring is given to demonstrate the ideas and algorithms proposed in this paper, and a simulation is made to show the performance of the proposed algorithms.[4] Sokratis Kartakis, Weiren Yu, Reza Akhavan, and Julie A. McCann entitled "Adaptive Edge Analytics for Distributed Networked Control of Water Systems" This paper presents the burst detection and localization scheme that combines lightweight compression and anomaly detection with graph topology analytics for water distribution networks. We show that our approach not only significantly reduces the amount of communications between sensor devices and the back end servers, but also can effectively localize water burst events by using the difference in the arrival times of the vibration variations detected at sensor locations. Our results can save up to 90% communications compared with traditional periodical reporting situations.[5]

III. 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

IV. PROBLEM STATEMENT

Monitoring water quality is crucial for protecting the environment and ensuring that people have access to safe and clean water for Drinking. The manual sample and analysis used in traditional water quality monitoring techniques is time-consuming, expensive, And inefficient. This strategy may cause problems with water quality to go undetected for longer, which could have detrimental Effects on human health and the environment.

Additionally, it is challenging to assess water quality over vast geographic areas since typical monitoring techniques are not scalable.A cost-efficient, scalable, and real-time water quality monitoring system that can deliver precise and fast information on water quality Parameters is required to address these issues. These issues can be resolved by an IoT-based method for monitoring water quality By utilising the capabilities of wireless sensor networks and cloud computing for Real-time data collection, analysis, and Dissemination of water quality. Nevertheless, choosing the right sensors, gathering and transmitting data, managing electricity, and integrating with cloud-based platforms are just a few of the logistical and technical issues that must be resolved throughout the design And deployment of such a system.[2]

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V. PROPOSED SYSTEM

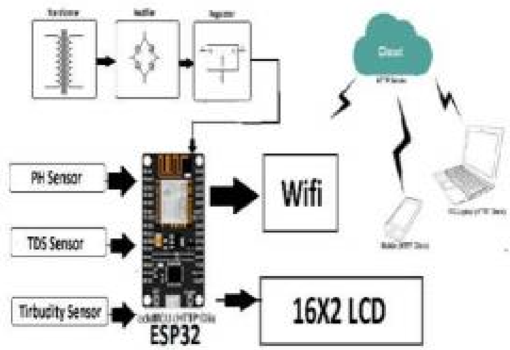

Fig.1 Block Diagram

Here, the benefits of real-time monitoring of water quality are discussed further. The general block diagram of the proposed approach Is shown above. The system's components are discussed in detail. Many sensors (including those for tds, pH, and turbidity) Are linked to the central controller in the suggested block diagram.

Our goal is to develop a system for real time quality assessment for water health at residential places using ESP32 microcontroller pH, Turbidity and TDS sensors are used to gather the parameters necessary to monitor water health in real time. Following are the objectives of the proposed system.

- To measure various chemical and physical properties of water like pH, temperature and particle density of water using sensors.
- Send the data collected to ESP32 microcontroller, show the data in display and send it to a cloud based Database using Wired/Wireless Channel.
- Data visualization and analysis using cloud based visualization tools

BLYNK app is installed in the android version to see the output. When the system get started dc current given to the kit and arduino and WIFI gets on. The parameters of water is tested one but one and their result is given to the LCD display. The app went provided with hotspot gives the exact value as on LCD display shows on kit. Thus like this when the kit is located on any specific water body and WIFI is provided we can observe its real time value on our android phone anywhere at any tim

VI. TECHNICAL DESCRIPTIONS

Turbidity sensors

The cloudiness or haziness of a liquid or fluid is measured using a turbidity sensor. Turbidity is a metric used To determine how many suspended particles or solids there are in a fluid. The amount of light reflected or absorbed by the fluid's Particles is determined by turbidity sensors. The amount of light emitted or absorbed by the fluid's particles is then measured by a Detector. The sensor emits a light beam. The turbidity of the fluid directly relates to the amount of light that is dispersed or Absorbed.[4]

Fig.2 Turbidity sensor

pH sensor

The acidity and basicity of a given solution can be determined by its pH value. The pH of a solution is measured between from 0 to 14 and its neutral point is always 7. Acidic solutions have their pH less than 7, basic solutions have their pH greater than 7. pH sensor can easily be integrated into an Arduino uno board which runs on a 5V supply. The pH of pure water isexactly 7.[5]

Fig3. pH sensor

Wi-Fi Module:

The microcontroller on Arduino uno can connect to a Wireless-Fidelity network using the ESP8266 Wireless-Fidelity Module, an independent SOC with a built-in TCP/IP protocol. The ESP8266 is used to connect the Arduino uno board to Connect to Wireless-Fidelity network using IEEE 802.11bgn and hosting or assigning another application processor to handle all Wi-Fi networking tasks. An Attention command set software is pre-installed into it [1]

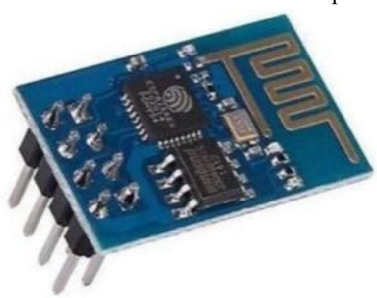

Fig. 4 Wi-Fi Module

ESP32 Microcontroller

ESP32 is the specifically built low-power consumption microcontroller for Internet of Things (IoT) projects. Fire Beetle Board-ESP32 combines a dual-core ESP- WROOM-32 module which supports dual-mode communication with MCU, Wi Fi and Bluetooth. Throughout the deep-sleep mode the electrical current is only 10µA. Two power distribution methods are assisted by the main controller: the USB and 3.7V internal lithium batteries. The Lipo Battery can be charged directly by both USB and external DC

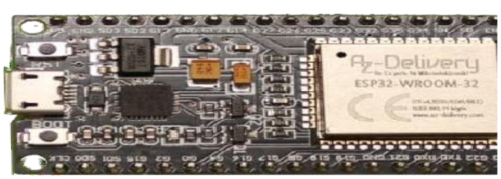

Fig. ESP32 Microcontroller

TDS sensors

The TDS sensor measures the concentration of dissolved solids in water. This includes minerals, salts, metals, and other particles. By measuring the TDS level, you can assess the overall quality of the water. Higher TDS values may indicate a higher concentration of impurities, while lower values may indicate purer water

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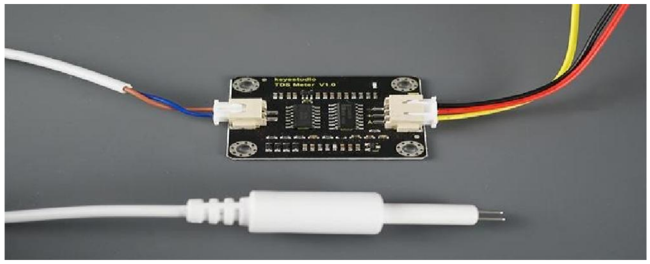

Fig. TDS sensor

16x2 LCD Display

The 16×2 I2C LCD display provides a convenient way to view the TDS value, EC, and water temperature in real time. With the readings displayed on the LCD, you can quickly assess the water quality without the need for complex analysis or external devices.

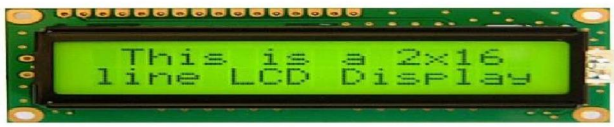

Fig. 16x2 LCD Display

The table below displays the metrics used by our system to measure water quality.

Threshold value of parameters

PARAMETER	SAFE WATER RANGE	UNSAFE WATER RANGE
pH	6.5 to 8.5	Belove 6.5, above 8.5
TDS	300 ppm to 500ppm	Belove 300ppm, above 500ppm
turbidity	5NUT to 50NUT	Belov 5NUT, above 50NUT

VII. RESULT

Testing water quality in real time in normal water

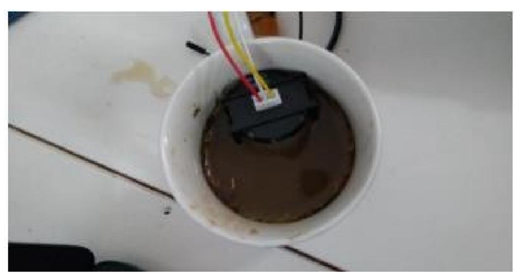

Fig: Collecting turbidity value from dirty water

Fig: Testing water quality in real time by mixing solvents in water

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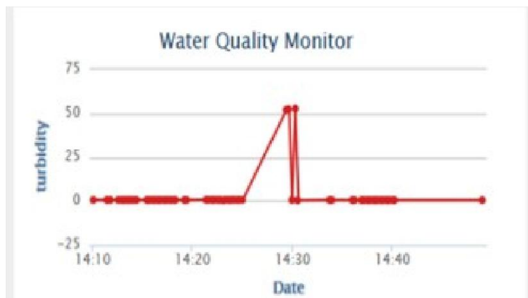
Real time visualization of pH variation i n water sample



Real time visualization of turbidity variation in water sample

VIII. CONCLUSION

In this paper, we discuss the latest technology that can help to Early detection of contaminants: IoT-based water quality monitoring systems can detect contaminants in water at an early stage, before they can become a major health hazard. This can help prevent outbreaks of waterborne diseases and reduce the risk of contamination in the water supply.

IX. FUTURE WORK

Detecting the more parameter for most secure purpose. Increase the parameter by adding of multiple sensors. By interfacing relay, we control the supply of water. remote monitoring of water quality, allowing water utilities to monitor their water supply from anywhere in the world. This can help reduce costs associated with on-site monitoring while still ensuring water q uality and safety.

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