Water Quality Monitoring System

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Abstract - Water is an essential resource for human life and crucial for various daily activities. The prevention of Aquatic pollution is a worldwide challenge. To assure the pure water access, the ongoing water quality surveillance is required. We present a model and development of a system for quality assessment of water through Internet of Things (IoT). This system consists of a microcontroller (ESP32) and multiple sensors to measure the water quality indicators such as pH, turbidity, ORP and TDS sensors. The sensors data is analysed by the microcontroller and output is shown on the LCD (Liquid Crystal Display). Concurrently, If the values are different with WHO standards of water quality measurements then an exact replica of the sensors readings are transferred remotely to the management and user's mobile as a SMS via GSM (Global System for Mobile) module. A cloud-based platform (Thingspeak) is used for virtual observation of water quality. The advantages of this system are early identification and alerting through notifications, lower cost, avoids human error, increase safety. As the system is automatic, it is faster in monitoring, so it helps in preventing the water before contamination.

Keywords: Microcontroller, Sensors, IoT, Turbidity, Thingspeak.

INTRODUCTION

Water is an irreplaceable source. It is an essential need for economic growth and environment. Based on the analysis of World Health Organization, 2 billion people are consuming contaminated water due to lack of water resources. This leads to several diseases like cholera, diarrhea and kidney diseases which causes 500000 of deaths[1]. The main reason of water contamination is usage of chemicals and fertilizers in various industries and these industrial wastages are directly flows into the water bodies[3]. The Central Pollution Control Board monitors the water resources throughout the country with regular time intervals but the fast growing of population and various activities of people accelerated the pollution[10].

The water purity is measured by considering the elements like pH, turbidity, electric conductivity, dissolved oxygen levels etc. The traditional system depends on manual inspection of water quality which includes collecting of water samples, testing and analyzing the results[6]. This leads to delayed detection of quality, includes human error and needs expert advice. The instantaneous monitoring of water is challenging as water contamination increases globally. In order to overcome the problems of traditional systems, IoT technology provides the timely monitoring system of water. Integration of IoT with sensor technology helps in detecting the water quality accurately with less power consumption and ease of operation[2]. The pH value indicates the amount or quantity of hydrogen ions. It presents the acidic and alkaline levels of solution where the pH range of water should be between 6.5 to 7.5 values. TDS sensor evaluates the level of dissolved substances in water. Turbidity determines the clouded appearance of water due to the inclusion of suspended particles or pollutants. Involvement of cloud platform and GSM modules works on simultaneous updates of sensor readings and sends notifications or alerts to the concerned authorities and end users.

RELATED WORK

Razvan Bogdan, Paliuc C, Crisan-Vida M, Nirmara S, Barmayoun D. [1] proposed a cost effective IoT Water Quality Monitoring System for Rural Areas. The components used in this system are Arduino UNO board for analysing, Bluetooth module for intimation, and several sensors like temperature, ph and turbidity to measure quality. It has the ability of measure quality of water. It analyse the parameters such as temperature, pH, electric conductivity. The system which is proposed is based on the board controlled by mobile application. The extension of this work includes the involvement of local councils and announcement of results to population.

Varsha Lakshmikantha, Anjitha Hiriyannagowda, Akshay Manjunath, Aruna Patted, Jagadeesh Basavaiah, Audre Arlene Anthony [2] developed Smart Water Quality Monitoring System using IoT technology that serves in monitoring of water quality parameters by testing three different samples of water. This system is the combination of sensors and wi-fi module. The values are displayed on LCD and based on the threshold values the user will be intimated. It measures the parameters like temperature, conductivity, pH, humidity and carbon dioxide levels in water. This system can be enhanced by using advanced or latest sensors for measuring other quality parameters.

Sathish P. & Sai Teja G.[3] designed a Smart Water Quality Monitoring System With Cost-Effective Using IoT. The proposed system had Arduino Mega and NodeMCU(ESP8266) integrated with the sensors pH, turbidity,DHT11 and ultrasonic sensors. This work includes measuring the level of water in the tank and uses a thingspeak- thingview mobile app for virtual surveillance of water quality indicators. The values were shown on the output screen of Arduino IDE. This work can be extended by analysing other parameters such as chlorine, nitrates and electric conductivity.

Konde and Deosarkar [4] suggested an approach to design a Smart Water Quality Monitoring (SWQM) system with advancements in Wireless Sensor Networks.
It includes the usage of FPGA (Field Programmable Gate Array) board and Zigbee module for the purpose of communication. The authors evaluated six types of quality factors such as ph, turbidity, humidity, level of water, temperature, and CO2 levels of water. The suggested work will extend support to protect the safer and balanced water body environment. It decreases the expenses and time duration in ascertaining the water quality assessment in water bodies as a part of maintaining ecological and environmental balance. This work suggests to include the cloud-based solutions to improve the abilities of existing monitoring systems.

Nikhil Kedia [5] titled "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. The paper includes water quality observing technique, sensors, and data transmission method, government role, administrate administrator and locals in ensuring proper data dispersal. It also explores the Sensor Cloud field. Although improving the water quality subsequently isn't currently possible, efficient use of innovation and financial practices can enhance water quality and awareness among individuals.

MATERIALS AND COMPONENTS

Microcontroller (ESP32)

Espressif Systems for IoT purposes with a dual-core processor that provides robust multitasking. The ESP32 provides support for both Wi-Fi and Bluetooth connectivity, which is very suitable for wireless communication in projects. Given low power, the ESP32 suits battery-powered devices, and it provides various I/O options for connecting sensors and peripherals. The microcontroller features onboard flash memory as well as external storage capabilities for bigger data requirements. It also offers security capabilities such as hardware encryption and secure boot, providing secure data transmission. The ESP32 is commonly used in smart home products, wearables, and environmental monitoring.

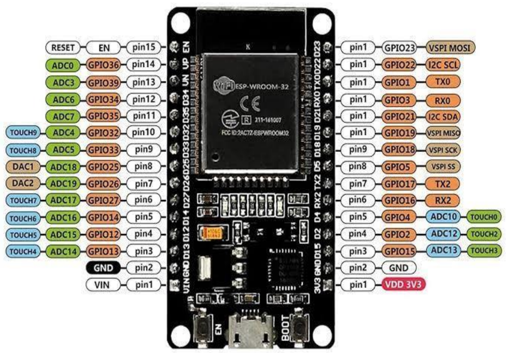

Figure 1: Microcontroller(ESp32)

PH Sensor

A water quality pH sensor determines the nature(acidic or alkaline) of water, reporting the level of H+ ions in the water. The pH level is from 0 to 14. This scale is divided as below 7, exact 7 and above 7 that indicates the acidic, neutral and alkaline nature of any solution[7]. pH is a crucial parameter in water quality since it influences aquatic life, the solubility of nutrients and the effectiveness of water purification procedures. Such sensors are usually composed of an electrode that creates a voltage as a function of the pH reading, which is then read and translated to a usable reading. pH sensors are widely used in environmental monitoring, industrial processes, and water treatment plants.

ORP Sensor

An ORP (Oxidation-Reduction Potential) sensor determines the oxidizing or reducing capacity measure of water, its general chemical reactivity. ORP is measured in millivolts (mV) and aid in determining the capacity of the water to neutralize pollutants, like bacteria, chemicals, and pollutants[8]. More oxidizing conditions are normally indicated by greater ORP values, which are best for disinfecting water, lower values indicate reducing conditions.

TDS Sensor

The quantity of salts, minerals and dissolved substances is detected by TDS sensor. It operates by sensing the electrical conductivity of the water, which rises with the amount of dissolved solids. High TDS may reflect poor quality water, and it could potentially harmful for consumption or industrial use.

Turbidity Sensor

A turbidity sensor is used to measure the dullness and clouded appearance of water occurred by involvement of suspended particles or pollutants. It works by emitting light through the water and detecting how much light is scattered by the particles[7]. The higher the turbidity, the more suspended particles are present, indicating potential contamination or poor water quality.

GSM Module

GSM(Global System for Mobile Communications) module is used for communication between microcontrollers and mobile networks[8]. Generally these serve in embedded system to transmit text messages, calls and connect to internet. It operates through a SIM card similar to mobile phone. It runs on either the 900MHz-1800MHzfrequency band[9].

SYSTEM ARCHITECTURE

System architecture represents the structure of the model or project. It shows the functionality of the system. The following diagram explains the structure of proposed system.

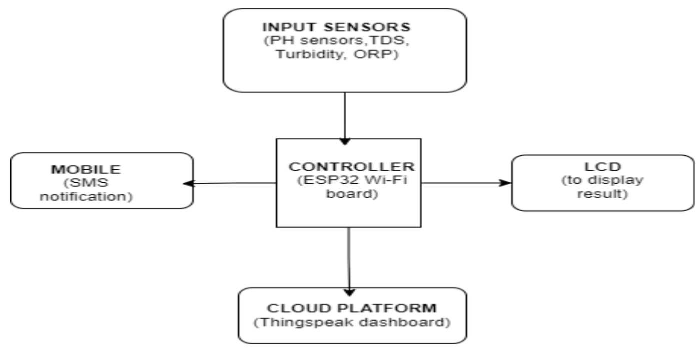

Figure 2: System Architecture

PROPOSED METHODOLOGY

The suggested system acquire measurable data on the physical features, chemical composition and biological characteristics of water. The system is composed of ESP32 and several sensors for the determination of quality factors of water. Values are processed through microcontroller board, as well as the outcomes are shown on Liquid Crystal Display. Meanwhile, another copy of numerical sensor values are remotely transmitted to the user's mobile phone as a short message service(SMS). There is remote observation available through a cloud based platform(Thingspeak). GSM module provides a direct contact in between system results, user and authorities of water quality management.

SOFTWARE IMPLEMENTATION

In this model Arduino IDE is used for project implementation. Arduino software consist of text editor for coding part. Various kinds of buttons are provided to run, debug and upload the program into the hardware. This software includes inbuilt ports and libraries.

Steps to be followed to implement the system:

1. Download Arduino IDE software
2. Power Up your board
3. Launch the Arduino environment
4. Start first task by using the new sketch
5. Select the Arduino board and serial ports

6. Upload the code into the hardware board

Thingspeak Setup

Thingspeak is an open source platform with capability of collecting, storing, analyzing and visualizing the data. It offers the channels to store the data collected from sensors. Thingspeak provides pictorials representation of data using graphs and charts. It assist the IoT developers as it encourages the integration of IoT devices.

Usage

Create a profile in Thingspeak by using your credentials. Create your own channel that provides 8 fields for each channel. Link your channel with hardware with the help of channel id, and API keys. Thingspeak offers four number of free channels for each profile.

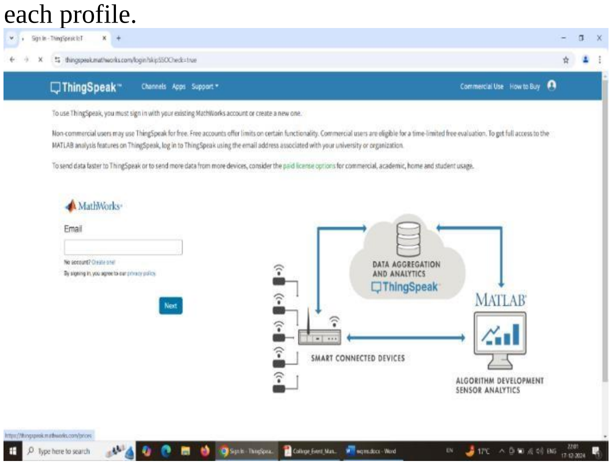

Figure 3: Thingspeak Channel

RESULTS

As the goal of water quality monitoring system using IoT technology is to examine the quality parameters and monitor simultaneously. By this system we monitored the factors like ph, turbidity, tds and orp levels of water. The values measured are shown on the liquid crystal display and for every 15 seconds the values are updated to the Thingspeak cloud platform. In the case of exceeding values the caution message will be sent to concerned authorities and end users.

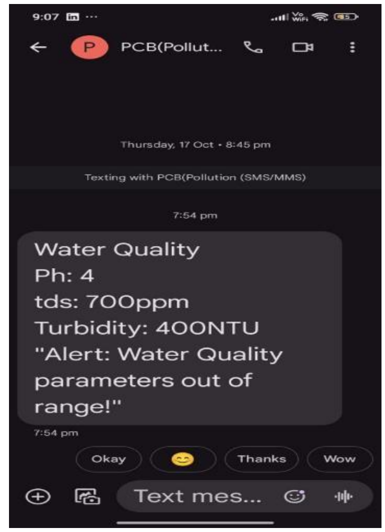

Figure 4: Alert Message

FUTURE SCOPE

The utilization of sophisticated sensors will enable detection of a wider range of pollutants, and blockchain technology will provide increased data security and transparency. With IoT systems becoming increasingly cost-effective and scalable, they will be utilized extensively, providing improved monitoring of water quality globally.

CONCLUSION

IoT-enabled water quality monitoring systems provide excellent advantages for enhanced water management and environmental conservation. IoT sensors track water quality in real-time, detecting contamination and offering constant monitoring of water quality and flow rates. By raising alarms upon a decline in water quality or flow rates, these sensors improve water usage to an optimal level and curb wastage. The information that IoT sensors obtain informs water management decisions, allows authorities to make better choices relating to resource allocation and conservation. Moreover, IoT-based systems are affordable and convenient since they are cheap to implement and necessitate low human monitoring. Further, the systems are adaptable, easily adaptable to observe extra water quality factors as the need arises, to ensure they continue being effective as water quality issues change.

REFERENCES

[1] Bogdan, R., Paliuc, C., Crisan-Vida, M., Nirmara, S., & Barmayoun, D. (2023). Low cost internet of things water quality monitoring system for rural areas. *Sensors*, *23*(8), 3919.

https://www.mdpi.com/1424-8220/23/8/3919

[2] Lakshmikantha, V., Hiriyannagowda, A., Manjunath, A., Patted, A., Basavaiah, J., & Anthony, A. A. (2021). IoT based smart water quality monitoring system. *Science Progress*, *104*(2), 1-11. https://www.sciencedirect.com/science/article/pii/S2666285X21 0 0090X

[3] Pasika, S., & Gandla, S. T. (2020). Smart water quality monitoring system with cost-effective using IoT. *Heliyon, 6*(12), e05606 https://www.cell.com/heliyon/fulltext/S2405-8440(20)30940-3

[4] Konde, S., & Deosarkar, S. (2020). IoT based water quality monitoring system. In *Proceedings of the 2nd International Conference on Communication & Information Processing (ICCIP) 2020*. SSRN. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3645467

[5] Kedia, N. (2015). Water quality monitoring for rural areas—A sensor cloud based economical project. *IEEE Xplore*. https://ieeexplore.ieee.org/abstract/document/7375081

[6] Rahman, M. M., Bepery, C., & Hossain, G. M. J. (2020). Internet of Things (IoT) based water quality monitoring system. *ResearchGate*. https://www.ijmcer.com/wpcontent/uploads/2023/07/IJMCER_T0 2401680180.pdf

[7] Daigavane, V. V., & Gaikwad, M. A. (2017). Water quality monitoring system based on IoT. *Advances in Wireless and Mobile Communications*.

[8] Prasad, A. N., Mamun, K. A., Islam, F. R., & Haqva, H. (2016). Smart water quality monitoring system. *IEEE Xplore*. https://ieeexplore.ieee.org/abstract/document/7476234

[9] Das, B., & Jain, P. C. (2017). Real-time water quality monitoring system using Internet of Things. *IEEE Xplore*. https://ieeexplore.ieee.org/abstract/document/8003942

[10] Singh, S., Kumar, A., Prasad, A., & Bharadwaj, N. (2018). IoT based water quality monitoring system. *International Journal of Research in Innovative Technology and Trends*, *4*(1), 1-6. https://web.archive.org/web/20180409222419id_/http://www.ijritt.org/paper/IJRITTV4IS30005.pdf