IOT BASED SMART WATER MANAGEMENT SYSTEM

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Abstract - Access to clean water is becoming ever more posing challenges because of population growth, urbanization, and climate change. The conventional water resource management regimes have struggled with inefficiencies such as leaks, consumption, and slow feedback regarding concerns. Our 10T-Based Smart Water Management System deals with the aforementioned challenges by integrating— intelligence and automation to the water supply network. This system employs 10T sensors and smart devices to constantly monitor the water level and quality. In the event that something goes wrong. incorrect, such as a "leak" or "contamination"—it is It sends signals immediately and alerting others via a mobile application or web dashboard[5]. It assists families in monitoring their daily water use, promotes conservation by consumption insights, and helps water utilities better utilize their resources efficiently. By integrating physical water infrastructure with digital technology, this aims at preventing water waste and costly damage due to leaks, maintain improved water quality, and ultimately to enable a sustainable use of this valuable resource. This is one of the steps towards making the management of water smarter. more responsive, and more responsible towards the coming generations.

Index Terms—IoT, Water Management System, Flow Sensors, Microcontroller, Cloud Platform, Wireless Connectivity, Data Analytics, Automated Monitoring .

I. INTRODUCTION

Water is one of the major elements required for human life, agriculture, and industry. With the rise in population and the growth of cities, the requirement for clean and sufficient water has significantly increased. However, improper use of water, leakage, and pollution of this resource have further led to severe water problems. In residential as well as industrial sites, the level of water and quality of water are measured manually, which further leads to ineffectiveness and the wastage of water as well as the delay in the identification of the presence of pollutants [4]. In traditional water management systems, there are no capabilities for online monitoring or accessibility[4]. It takes time to physically monitor the water tanks and conduct laboratory tests for water quality checks. Therefore, when issues such as water overflow, water shortage, and poor water quality occur in the water management system, they are identified only when their consequences result in serious damages. This illustrates the significance of developing an automated and intelligent system that has the capabilities of continuous monitoring.

Such challenges have found their effective solution in the Internet of Things, allowing for the collection, monitoring, and dissemination of real-time data with the help of the internet[2]. Integration of sensors, microcontrollers, and wireless communication presents the possibility of continuous monitoring of water level and quality without interference from humans[3]. This, in turn, enhances accuracy and saves labor while enabling the user to access information from anywhere around the world[6].

This project realizes an IoT-based Smart Water Management System to monitor water level and main water quality parameters such as pH, turbidity, TDS, and temperature[5]. An ESP32 microcontroller is used to collect data from sensors and transmit it to the cloud platform through Wi-Fi[3]. Simultaneously, the system demonstrates real-time value display locally on the OLED screen. The key goal of this project is the reduction of water wastage, enhancement of water quality monitoring, and the facilitation of efficient and sustainable water management practices[6].

II. LITERATURE REVIEW

Water scarcity and water pollution are two issues that have recently gained widespread attention throughout the world, owing to the rapid increase in the population of the world. Due to this, several researchers have explored the use of Internet of Things technology for improving water management. This section discusses research work performed for smart water level sensing and water quality analysis[l] [2].

Manual and semi-automatic systems, which were previously used in the surveillance and monitoring of water, involved human intervention and verification. This required time and often failed to provide an alert concerning abrupt changes in the water quality and/or water levels. Taking all these challenges and shortcomings into consideration, the emergence of auto systems via sensors gained prominence but lacked instant remote access. Certain authors have developed water level monitoring systems using ultrasonic sensors/float sensors on the 10T technology. Their works could monitor the water levels online, which prevents overflow as well as dry-running of the water. Most of their works were concerned only with the water level aspect, without considering the water quality aspects[4].

More recently, research has been extended towards IoT-based water quality monitoring. Researchers employed sensors including pH, turbidity, TDS, and temperature to determine the safety of water. Systems like these are usually designed with microcontrollers such as Arduino and ESP32 in order to send reports onto cloud services. However, these solutions were limited by accuracy concerning poor calibration and power consumption.[5] With the integration of cloud computing and mobile applications, some of the modern technologies have enabled the remote access of water data. The technologies improved user consciousness and decision-making. In fact, most of them proved expensive and intricate, thus not applicable in small or domestic settings.

The water level and water quality monitoring are combined in a single process in some of the research studies. The systems provided a more holistic solution but tended to involve the control of the water flow. This made the systems more complex. Simpler systems tended to be more dependable and manageable. As uncovered during the literature review, there is an emerging need for cost-effective and efficient Internet of Things-based water quality testing systems that are not stuffed with unnecessary complexities. The proposed work shall fulfill such a need by using multiple sensors and ESP 32 technology.

III. METHODOLOGY

The section elaborates on the main steps followed in the design and implementation of the 10T-based Smart Water Management System. It encompasses the overall idea of the system, components used, software development, calibration, data monitoring, mobile connectivity, and data storage that together make the system reliable and easy to operate.

A.System Overview:

The Smart Water Management System using 10T will be used to monitor the water level, as well as water quality, in a water tank or water body[6]. The device will neither control water flow nor measure water flow. Hence, this makes it simple and economic. 10T will be used.

It has multiple sensors that check water level, pH value, turbidity, TDS, and water temperature[5]. All these sensor readings are processed by a microcontroller and then transmitted to a smartphone application or cloud server[2]. This is an effective way for consumers to know water conditions at their end and act accordingly if water crosses safe limits for any parameter.

B. Component Selection and Justification:

During the selection of the components, the following parameters played an extremely important part: accuracy, reliability, low power consumption, availability, and cost. In this design, the microcontroller used is ESP 32, which was chosen because of the presence ofWi-Fi and Bluetooth in ESP 32[3].

The ultrasonic sensor is used to detect the water level without the need to touch it. pH Sensors, Turbidity Sensors, T DS Sensors, and Temperature Sensors are used for analyzing water quality, as these parameters directly affect the usability and health aspects of water[5].

The OLED display provides an instantaneous local display of the values, such that the values can be monitored without the use of a mobile phone. Every factor contributes towards creating an efficient monitoring system.

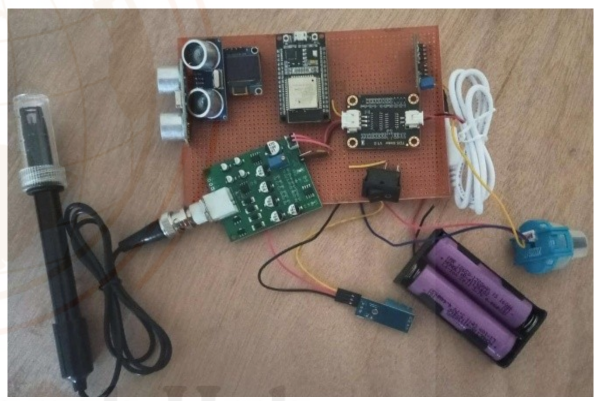

Fig : Prototype of Project

C. Software Development:

The software component deals with processing and transmitting meaningful data coming from sensors. The ESP32 firmware is created using C/C++ in an Arduino environment[3]. The microcontroller is constantly reading data from all the sensors that are connected. It uses basic filtering to eliminate noises as well as unreliable results. The sensors do not display raw results as they normally produce information that is easily understandable, like safe or unsafe water. The pre-defined values of the thresholds are assigned to different parameters. If any parameter violates the safe limit, it triggers the system generate notifications, which update the information displayed on the mobile application or cloud dashboard[6].

D. Calibration Procedure:

For exact measurements, calibration of these sensors is done prior to implementation. First, the readings are taken when the sensors are set up in standard or clean water. The pH sensor is calibrated with known buffer solutions. The T DS and Turbidity Sensors are compared using reference water samples. The temperature sensor is verified by using an external thermometer. Through this, the system's calibration will be improved, thus reducing the errors associated with the various measurements [5].

E. Real-Time Monitoring Module:

The system always monitors the parameters related to the level of water and the quality of the water online. The data provided by sensors is shown on the OLED display. The system will help monitor abnormal conditions such as low levels of water, high levels of turbidity, and inappropriate pH levels with ease[6].

F. Mobile App / Cloud Connectivity:

The system is linked through a mobile application or cloud service via Wi-Fi or Bluetooth connectivity. Users are able to monitor real-time data, notifications, and past readings directly from their mobile devices. This remote monitoring function makes the system quite user friendly and ideal for homes, apartments, industries, as well as water treatment plants[3].

G. Data Logging Feature:

The system retains records of water levels and quality over time. Through this, water utilization patterns can be analyzed, as well as the changes in water quality. Through analysis and understanding of the trends, the users can make proper utilization of water conservation and management decisions to ensure safe and efficient use of water[6].

IV. OBJECTIVE

1. For designing and developing an internet of things (IOT) system for the continuous monitoring of the water level and quality parameters.
2. To monitor the important water quality parameters like pH value, Turbidity, Total Dissolved Solids (TDS), and Temperature.
3. To measure the water level using non-contact sensing methods accurately.
4. To show real-time water level information and water quality data using an OLED display.
5. For the wireless transmission of sensor information via Wi-Fi or Bluetooth for distant observation.
6. To create an alert whenever water quality attributes exceed predefined safe limits.
7. To retain water information that will be used later to analyze water use and quality patterns.
8. Providing a friendly user interface through a mobile application or cloud-based interface.
9. Ensuring the system is cost-effective, reliable, and easy to deploy in both domestic and industrial contexts.
10. To encourage good water resource management and knowledge of the need to detect unsafe conditions in the water.

V. PROBLEM FORMULATION

Water resources is under pressure not only because of an increased population but also because of industrial operations. In most domestic and industrial settings, it is possible to determine water level and quality. This is especially so when it comes to determining water quality variables such as pH, turbidity, and TDS, which at times can vary, and most instances remain unchecked.

The current automatic systems are either costly, complicated, and are only focused on the level of the water and not on the whole aspects of the water quality. There is a need to fill the void that is created by the absence of an affordable and easy Monitoring System of Water Quality. Therefore, the problem at hand relates to the design and implementation of the 10T-based intelligent water management system that can monitor the level and quality of the water in real time, provide notifications for dangerous levels and quality of the water, and store the data for future analysis without controlling the flow of the Water.

VI. RESULTS

The design and development of the proposed Smart Water Management System using 10T have been successfully accomplished. Measuring the water level is accomplished by an ultrasonic sensor. Water parameters such as pH, Turbidity, TDS, Temperature have been used[5], The acquired values were shown live using an OLED display. Further, the values were uploaded to the cloud services or mobile application via Wi-Fi or Bluetooth connectivity[6]. If the value happened to go beyond the range regarded as safe, an alert message would be triggered immediately. The calibration of the sensors increased the accuracy of the data they could provide. The fact that the system could record the data enabled the user to analyze the trend of the water level and the water quality . The efficient system required less power and has a quick response time [5] .

VII. CONCLUSION

A Smart Water Management System using 10T technology for water level monitoring and water quality was successfully developed and implemented. The benefits include remote access and logging capabilities, making water management easy and efficient[6]. Since the system concentrates only on detection and monitoring, the system is simple and less expensive to deploy, both at home and at the industrial level. From the results, the system is able to facilitate the early detection of unsafe water conditions, reduce manual labor, and ensure proper management of water resources. Future developments may include the integration of predictive analytics capabilities and the ability to connect to "smart" city platforms, as well as the extension of the technology to full scale water distribution systems[l].

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IX. REFERENCES

[1] I. F. Akyildiz, W. Su, Y. Sankarasubramaniam, and E. Cayirci, "A survey on sensor networks," IEEE Communications Magazine, vol. 40, no. 8,

[2] L. Da Xu, W. He, and S. Li, "Internet of Things in industries: A survey," IEEE Transactions on Industrial Informatics, vol. 10, no. 4, pp. 2233-2243, 2014.

[3] P. P. Ray, "A survey on Internet of Things architectures," Journal of King Saud University Computer and Information Sciences, vol. 30, no. 3, pp. 291-319, 2018.

[4] S. R. Kodali and S. K. Mahesh, "Smart water level monitoring system using IOT," International Journal of Engineering Research & Technology (IJERT), vol. 5, no. 3, pp. 357360, 2016.

[5] N. Vijayakumar and R. Ramya, "The real time monitoring of water quality in 10T environment," International Journal of Innovative Research in Science, Engineering and Technology, vol. 4, no. 7, pp. 555-560, 2015.

[6] A. Geetha & S. Gouthami, "Internet of Things enabled real-time water quality monitoring system," Smart Water, Springer, vol. 2, no. 1, pp. 1 - 19 .

[7] K. Gopavanitha and S. Nagaraju, "A low cost system for real time water quality monitoring and controlling using IoT," in Proc. 2017 Int. Conf. on Energy, Communication, Data Analytics and Soft Computing (ICECDS), Chennai, India, 2017, doi: 10.1109/ICECDS.2017.8390054.

[8] B. Das and P. C. Jain, "Real-time water quality monitoring system using Internet of Things," in Proc. 2017 Int. Conf. on Computer, Communications and Electronics (Comptelix), Jaipur, India, 2017, pp. 78–82, doi: 10.1109/COMPTELIX.2017.8003942.

[9] M. S. U. Chowdury et al., "IoT based real-time river water quality monitoring system," Procedia Computer Science, vol. 155, pp. 161–168, 2019, doi: 10.1016/j.procs.2019.08.025.

[10] [10] S. A. H. AlMetwally, M. K. Hassan, and M. H. Mourad, "Real time Internet of Things (IoT) based water quality management system," Procedia CIRP, vol. 91, pp. 478–485, 2020, doi: 10.1016/j.procir.2020.03.107.

[11] S. Pasika and S. T. Gandla, "Smart water quality monitoring system with cost-effective using IoT," Heliyon, vol. 6, no. 7, Art. no. e04096, Jul. 2020, doi: 10.1016/j.heliyon.2020.e04096.

[12] V. Lakshmikantha et al., "IoT based smart water quality monitoring system," Global Transitions Proceedings, vol. 2, no. 2, pp. 181–186, Nov. 2021, doi: 10.1016/j.gltp.2021.08.062.

[13] W. A. Jabbar et al., "Development of LoRaWAN-based IoT system for water quality monitoring in rural areas," Expert Systems with Applications, vol. 242, Art. no. 122862, May 2024, doi: 10.1016/j.eswa.2023.122862.

[14] A. M. Alghamdi et al., "LoRaWAN performance analysis for a water monitoring and leakage detection system in a housing complex," Sensors, vol. 22, no. 19, Art. no. 7188, 2022, doi: 10.3390/s22197188.

[15] E. F. Khairullah et al., "LoRaWAN-based smart water management IoT applications: A review," Journal of Information and Telecommunication, 2025, doi: 10.1080/24751839.2025.2458889.

[16] F. Jan, N. Min-Allah, and D. Düştegör, "IoT based smart water quality monitoring: Recent techniques, trends and challenges for domestic applications," Water, vol. 13, no. 13, Art. no. 1729, 2021, doi: 10.3390/w13131729.

[17] M. Miller et al., "IoT in water quality monitoring—Are we really here?," Sensors, vol. 23, no. 2, Art. no. 960, 2023.

[18] K. S. Adu-Manu, C. Tapparello, W. Heinzelman, F. A. Katsriku, and J. D. Abdulai, "Water quality monitoring using wireless sensor networks: Current trends and future research directions," ACM Transactions on Sensor Networks, vol. 13, no. 1, Art. no. 4, 2017, doi: 10.1145/3005719.

[19] M. H. Banna et al., "Online drinking water quality monitoring: Review on available and emerging technologies," Critical Reviews in Environmental Science and Technology, vol. 44, no. 12, pp. 1370–1421, 2014, doi: 10.1080/10643389.2013.781936.

[20] OASIS, "MQTT Version 3.1.1," OASIS Standard, Oct. 29, 2014