SYNOPSIS

Report on

Water Quality Detection

by

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ABSTRACT

The rising concern over water pollution, as evidenced by the identification of numerous polluted river stretches in India by the Central Pollution Control Board in 2018, underscores the urgent need for effective monitoring and remediation strategies. In response, innovative solutions such as IoT-based water quality monitoring systems have gained prominence. These systems represent a paradigm shift from traditional monitoring methods by harnessing the power of sensor technology, connectivity, and cloud computing to provide real-time insights into water quality. At the heart of IoT-based water quality monitoring systems are sensors capable of measuring a range of parameters critical to assessing water quality. These sensors, including those for pH, dissolved oxygen, turbidity, conductivity, and temperature, are integrated into Microcontroller Units (MCUs) responsible for data collection and initial processing. By continuously monitoring these parameters in real-time, IoT-based systems offer a comprehensive understanding of water quality dynamics, enabling prompt detection of pollution events and timely intervention measures. Once collected, the data from sensors is processed and analysed on Personal Computers (PCs) or gateway devices. Advanced algorithms can be applied to identify patterns, anomalies, and trends indicative of water pollution. The seamless transmission of data to the cloud via IoT platforms like ThingSpeak revolutionizes the accessibility and scalability of water quality monitoring. Cloud-based storage and analytics enable stakeholders to access real-time data from anywhere with an internet connection, facilitating remote monitoring and decision-making. Moreover, the cost-effectiveness of IoT-based water quality monitoring systems presents a compelling advantage over traditional methods. By automating data collection, transmission, and analysis processes, these systems minimize the need for manual intervention, reducing labour and equipment expenses. Furthermore, the use of wireless communication technologies eliminates the need for costly infrastructure such as wired networks, making IoT-based solutions more accessible and adaptable to diverse environmental settings.

Keywords: Water Quality Monitoring; Internet of Things; Sensor Detection; Pollution Detection; Microcontroller Unit (MCU); ThingSpeak Application; Environmental Monitoring; Real-time Monitoring; Water Pollution; Remote Sensing; Adaptive Architecture;

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INTRODUCTION

The paper introduces an enhanced architecture designed to intelligently monitor water bodies such as ponds and rivers, particularly in proximity to human settlements like towns, villages, and cities. The proposed system leverages IoT-based techniques to extract relevant information concerning water quality. The architecture aims to achieve several key objectives: firstly, it seeks to improve upon existing monitoring frameworks near populated areas, enhancing the effectiveness of water quality assessment and management. Secondly, the system focuses on detecting water toxicity and promptly alerting relevant authorities to mitigate potential hazards. Additionally, it aims to raise awareness among the public about the consequences of toxic water, emphasizing the importance of water quality for various daily activities beyond bathing. By educating individuals about the harmful effects of polluted water on health and daily chores, the proposed architecture aims to empower communities to take proactive measures to safeguard their well-being and environment.

Water Quality Monitoring System:

Water quality monitoring systems play a crucial role in assessing and maintaining the health of aquatic ecosystems. These systems utilize various sensors to measure parameters such as pH, dissolved oxygen, turbidity, conductivity, and temperature in water bodies. The data collected from these sensors provides insights into the condition of water resources, helping to identify pollution sources, track trends, and inform management decisions.

Importance of Water Quality Monitoring:

The importance of water quality monitoring stems from its critical implications for human health, environmental sustainability, and economic development. Access to clean and safe water is essential for drinking, agriculture, industry, and ecosystem services. Monitoring water quality ensures compliance with regulatory standards, prevents contamination-related health risks, protects biodiversity, and supports sustainable water resource management.

Challenges with Previous Work:

Previous approaches to water quality monitoring have faced several challenges. One common issue is the limited spatial and temporal coverage of monitoring efforts. Traditional methods, such as manual sampling and laboratory analysis, are labor-intensive, time-consuming, and often provide only snapshots of water quality at specific locations and times. This limitation makes it difficult to capture the dynamic nature of water quality and detect pollution events promptly. Additionally, the high cost associated with equipment, infrastructure, and personnel restricts the scalability and accessibility of monitoring programs, particularly in resource-constrained regions. Moreover, the lack of real-time data availability hinders timely decision-making and response to pollution incidents, potentially exacerbating environmental and public health risks.

Solving Challenges with IoT:

To overcome these challenges, we propose leveraging the Internet of Things (IoT) technology to revolutionize water quality monitoring. IoT-based systems offer several advantages over traditional methods. By integrating sensor technology, connectivity, and cloud computing, IoT enables continuous, real-time monitoring of water quality parameters across vast geographical areas. This approach provides comprehensive coverage, allowing for the detection of pollution events as they occur. Moreover, IoT-based systems facilitate remote data collection, analysis, and visualization, enhancing accessibility and enabling stakeholders to make informed decisions promptly. The scalability and cost-effectiveness of IoT solutions make them suitable for widespread deployment, even in remote or resource-limited areas. Overall, IoT holds great promise in addressing the challenges associated with water quality monitoring, paving the way for more effective and sustainable management of water resources.

LITERATURE REVIEW

In [1: Yasin, S. N. T. M., Mohd Fauzi Mohd Yunus, and Nur Bahiyah Abdul Wahab. "The development of water quality monitoring system using internet of things." J. Educ. Learn. Stud 3 (2020): 14.] Sharifah Nurulhuda Tuan Mohd Yasin's goal is to develop a wireless water quality monitoring system that aids in continuous measurements of water conditions based on pH and turbidity measurements, and the primary objective of this study is to develop IoT water quality monitoring systems that aid in continuous measurements of water conditions. Sensors are typically used in IoT environmental monitoring apps to help protect the environment by gauging water quality. They used landing sensors to measure the parameters and GPRS (general packet radio service) to send the data to the base station. While reading, the information gathered can be used for analysis, documentation, display, and alerting the man to the status of the river.

In [2: Sengupta, Bharati, et al. "Water quality monitoring using IoT." Int. Res. J. Eng. Technol. 6 (2019): 695-701.] Bharati Sengupta focuses on monitoring factors such as pH, turbidity, and water temperature that can be verified on a daily basis. They used IoT to develop a system for monitoring and controlling hydrology in real time. The system is composed of physio-chemical sensors that can measure physical and chemical water variables such as temperature, turbidity, pH, and flow. The water quality parameters are visible in real time to the concerned authorities on the web server, empowering them to take any necessary action.

In [3: Vergina, S. Angel, et al. "A real time water quality monitoring using machine learning algorithm." Eur. J. Mol. Clin. Med 7 (2020): 2035-2041.] S. Angel Vergina employs pH, Turbidity, and Conductivity sensors to determine water quality parameters such as hydrogen ion and total dissolved solvents. Similarly, with the additional assistance of prepared informational collection from various water tests, K Means calculation has been used to predict the nature of water. Sweeping and comparing water quality parameters with time-stamped prediction results in the cloud server was communicated to the water analyst via personal computers for a better understanding and knowledge of water quality. Using low-cost embedded devices such as the Arduino Uno and Raspberry Pi, this proposed model ensures that rural residents have access to high-quality water.

In [4: Chaudhari, Neha, et al. "Water Monitoring System-IoT." (2020).] Neha Chaudhari employs tank water level monitoring to prevent the tank from overflowing. Water pollution monitoring can help in the sensing of water pollution, contamination, and toxic chemical discharge into bodies of water. Temperature, pH, and turbidity are also used to assess quality. These common parameters are gathered from river/lake water. To screen the water quality, the author used a Raspberry Pi as the core controller and a variety of sensors. It connects various sensors to the

Raspberry Pi to monitor the water's conditions. Raspberry Pi is in charge of accessing and processing the data. The Thing Speak App can be used to view the sensor data in the cloud.

P. B. Borole uses an embedded-based web server instead of a PC-based server in [5: Punpale, Abhijeet S., and P. B. Borole. "Water quality monitoring and control using IoT and industrial automation." IJSTE 4.12 (2018): 133-238.]. The Raspberry Pi board can be used to implement an embedded web server. This server enables remote monitoring of the industrial environment, as well as web access to the automation and monitoring system, and it also enables remote control of industrial appliances. The user can navigate the system's web page using alocal web browser and control industrial devices and monitor their status from a remote location. This project creates a low-cost electronic system for remotely monitoring and controlling industrial devices via web browser.Vennam Madhavireddy projected the water quality observation interface sensors with quality observation using IOT settings in [6: Madhavireddy, Vennam, and Bonagiri Koteswarrao. "Smart water quality monitoring system using IoT technology." Int. J. Eng. Technol 7.4.36 (2018): 636.]. WQM selects water parameters including temperature, pH level, water level, and CO2 using multiple device nodes. The statistics is delivered to the web server using this method. The data updated at periodic times on the server can be retrieved or accessed from anywhere in the world. If the sensors fail or enter abnormal conditions, a buzzer will sound. The interfacing between transducers and the sensor network on a single chip solution is accomplished wirelessly by using a WI-FI module. The system is achieved with reliability and feasibility for the monitoring process by verifying the four water parameters.

Gowthamy J proposes a low-cost water monitoring system as a solution for water waste and water quality in [7: Gowthamy, J. C. R. R., et al. "Smart water monitoring system using IoT." International Research Journal of Engineering and Technology 5.10 (2018): 1170-1173.]. For that system, microcontrollers and sensors are used. Water level is determined using an ultrasonic sensor. Other water parameters including pH, TDS, and turbidity can be calculated using various corresponding sensors. This system employs a flow sensor to measure water flow, and if the necessary amount of water flows through the pipe, the water flow is automatically stopped. A prototype water monitoring system based on IoT is presented in this paper. Some sensors are used for this. The data collected from all of the sensors is analyzed for better water problem resolution.In [8: Pasika, Sathish, and Sai Teja Gandla. "Smart water quality monitoring system with cost-effective using IoT." Heliyon 6.7 (2020): e04096.], Sathish Pasika Water Quality Monitoring (WQM) is a cost-effective and efficient system designed to monitor drinking water quality which makes use of Internet of Things (IoT) technology. In this paper, the proposed system consists of several sensors to measure various parameters such as pH value, the turbidity in the water, level of water in the tank, temperature and humidity of the surrounding atmosphere. And also, the Microcontroller Unit (MCU) interfaced with these sensors and further processing is performed at Personal Computer (PC). The obtained data is sent to the cloud by using an IoT based ThinkSpeak application to monitor the quality of the water.In [9: Jamroen, Chaowanan, et al. "A standalone photovoltaic/battery energy-powered water quality monitoring system based on narrowband internet of things for aquaculture: Design and implementation." Smart Agricultural Technology 3 (2023): 100072.], Chaowanan Jamroen presents a standalone photovoltaic (PV)/battery energy storage (BES)-powered water quality monitoring system based on the narrowband internet of things (NB-IoT) for aquaculture. (1) A PV/BES system was used as the main energy system of the monitoring system. The PV and BES capacities were optimized to provide uninterrupted electrical energy to the monitoring system, taking into account two techno-economic criteria: a maximum reliability index (RI) and a minimum levelized cost of energy (LCOE). Additionally, sensitivity analyses were conducted to investigate the effects of changes in PV generation and system consumption on the RI to improve the resilience of the PV/BES system. (2) The NB-IoT-based remote monitoring system was developed to aggregate water quality parameters such as dissolved oxygen, potential of hydrogen, temperature, turbidity, and salinity in order to provide early warning of severe water quality. Subsequently, the water quality data were used to calculate the water quality suitability index (WQSI).BES power, and state of charge.From the energy system viewpoint, the optimal techno-economic size of the PV/BES system was determined to be a PV capacity of 50 Wp and a BES capacity of 480 Wh, with an RI of 100% and a minimum LCOE of 0.61 $/kWh. The experimental results revealed that the system could operate continuously and stably without losing power supply. Furthermore, the results demonstrated that the proposed system achieved adequate communication vc 9 reliability, with a packet loss rate of 0.89%, thereby allowing for reliable near real-time monitoring of the WQSI.

In [10: Pasika, Sathish, and Sai Teja Gandla. "Smart water quality monitoring system with cost-effective using IoT." Heliyon 6.7 (2020): e04096.], Sathish Pasika Wireless communication developments are creating new sensor capabilities. Water Quality Monitoring (WQM) is a cost-effective and efficient system designed to monitor drinking water quality which makes use of Internet of Things (IOT) technology. In this paper, the proposed system consists of several sensors to measure various parameters such as pH value, the turbidity in the water, level of water in the tank, temperature and humidity of the surrounding atmosphere. And also, the Microcontroller Unit (MCU) interfaced with these sensors and further processing is performed at Personal Computer (PC). The obtained data is sent to the cloud by using an IOT based ThinkSpeak application to monitor the quality of the water .In [11:Doni, Ashwini, Chidananda Murthy, and M. Z. Kurian. "Survey on multi sensor based air and water quality monitoring using IOT." Indian J. Sci. Res 17.2 (2018): 147-153.], Ashwini Doni suggests the current methodologies include analyzing various kinds of physical and chemical parameters. The old method of quality detection and communication is time consuming, low precision and costly. Therefore, there is a need for continuous monitoring of water quality systems in real time.By focusing on the above issues, a low cost monitoring system to monitor water in real time using IoT is proposed. In this system quality parameters are measured using different sensors such as pH, turbidity, temperature and communicating data onto a platform of microcontroller system and GPRS are used.

In [12: Ashwini, C., Uday Pratap Singh, and Ekta Pawar. "Shristi Water quality monitoring using machine learning and iot." Int. J. Sci. Technol. Res 8 (2019): 1046-1048.], C.Ashwini presents a system that is proposed to check the water quality and warn the user before water gets contaminated .There are different parameters that can contaminate the water. These parameters are taken into account and used for predicting when to clean the water. The system uses technologies such as IoT and Machine Learning. It consists of the physical and chemical sensor to measure pH, turbidity ,color, DO, conductivity etc. to check the parameters .The data obtained from the sensors are recorded in the database and further sent for analysis. The neural network algorithm is used for predicting the result. It is used to obtain non-linear relationships for predicted output. The system sends the alert message to the user when any of the parameters are lower than the standard values. This helps the user to know beforehand about the contamination of water in their residential tanks. This technique can not only be limited up to residential tanks but can also be used in water treatment plants and industries.

In [13: Haque, Halima, et al. "IoT based water quality monitoring system by using Zigbee protocol." 2021 International Conference on Emerging Smart Computing and Informatics (ESCI). IEEE, 2021.], Jayti Bhatt, present the design of an IOT based water quality monitoring system that monitors the quality of water in real time. This system consists of some sensors which measure the water quality parameters such as pH, turbidity, conductivity, dissolved oxygen, temperature. The measured values from the sensors are processed by a microcontroller and these processed values are transmitted remotely to the core controller that is the raspberry pi using Zigbee protocol. Finally, sensor data can be viewed on internet browser applications using cloud computing. In [14: Daigavane, Vaishnavi V., and M. A. Gaikwad. "Water quality monitoring system based on IoT." Advances in wireless and mobile communications 10.5 (2017): 1107-1116.], Suruchi Pokhrel proposes a low-cost monitoring system that can monitor water quality such as pH (potential of Hydrogen) and conductivity on a timely basis using the Internet of Things. The water quality monitoring sensors sense the necessary physical parameters and convert them into equivalent electrical form, i.e. by providing a certain voltage as an output corresponding to the respective physical quantity. This value is mapped to the respective water quality measure and is stored in a database through the microcontroller using the Internet of Things. This aids the suppliers to centralize the regular monitoring of water from various locations as well as the supply of pure water to the end-users.

Table 1 Previous inventions by various authors focusing different water quality components.

S. No.	Author	Year	Focus Area
1	[1]	2020	PH, turbidity for measuring water quality.
2	[2]	2019	PH, turbidity and temperature for measuring water quality using physio-chemical sensors.
3	[3]	2020	Hydrogen ions and total dissolved solvents for measuring water quality
4	[4]	2020	PH, turbidity and temperature for measuring water quality used core controllers and a variety of sensors
5	[5]	2018	Focus on remote monitoring of the industrial environment, as well as web access to automation and monitoring systems.
6	[6]	2018	Focus on temperature, PH, water level and CO2 using multiple device nodes
7	[7]	2018	Water parameters including PH, turbidity, TDS for measuring water quality.
8	[8]	2020	Monitor water quality on the bases of pH, turbidity and microcontroller unit(MCU)
9	[9]	2023	Measures the water quality parameters of PV/BES, reliability index
10	[10]	2020	pH, turbidity and microcontroller unit(MCU)to measure the quality of water
11	[11]	2018	Quality parameters are measures on the bases of pH, turbidity, microcontroller system and GPRS
12	[12]	2019	pH, turbidity, DO, color, conductivity to check parameters.
13	[13]	2021	Measuring pH, turbidity, conductivity, dissolved oxygen temperature for measuring water quality
14	[14]	2017	Focuses on pH, Conductivity for measuring water quality

RESEARCH OBJECTIVES

The research objectives of this paper encompass a comprehensive approach to addressing the challenges associated with water quality monitoring in proximity to human settlements. Firstly, the paper aims to propose an improved architecture specifically tailored for monitoring water bodies located near towns, villages, and cities. These areas often face unique challenges due to human activities and infrastructure development, necessitating a specialized monitoring framework. By enhancing the existing architecture, the research endeavours to optimize the effectiveness and reliability of water quality assessment and management in these critical areas.

Secondly, the paper seeks to leverage IoT-based techniques to augment the capabilities of water quality monitoring systems. By harnessing the power of IoT, the proposed architecture aims to enhance the efficiency of data collection, transmission, and analysis, enabling real-time monitoring and prompt detection of water toxicity. Through the integration of IoT technologies, the research aims to provide a comprehensive solution that not only monitors water quality but also facilitates timely intervention measures to mitigate potential hazards and protect public health.

Furthermore, the paper aims to raise awareness among the public about the consequences of toxic water through effective communication and dissemination of information. By highlighting the environmental and health risks associated with polluted water, the research endeavours to foster a greater understanding of the importance of water quality for various daily activities. Through educational initiatives and outreach programs, the paper seeks to empower individuals and communities to take proactive measures to safeguard their well-being and environment.

Lastly, the research aims to educate individuals about the potential health risks posed by polluted water and its impact on daily chores. By emphasizing the importance of clean and safe water for activities beyond bathing, such as cooking, cleaning, and irrigation, the paper aims to install a sense of responsibility and urgency in addressing water quality issues. Through targeted awareness campaigns and educational materials, the research aims to equip communities with the knowledge and resources needed to protect themselves from the harmful effects of polluted water and promote sustainable water management practices. Overall, the research objectives outlined in this paper encompass a holistic approach to addressing the complex challenges of water quality monitoring and management near human settlements.

RESEARCH METHODOLOGY

In this project we came up with a solution where we will create a prototype including several sensors such as PH sensor, Lead sensor, Chlorine sensor, TDS sensor, Turbidity sensor and temperature sensor to sense the following factors of the water which affect the quality of the water. Sensors senses the factors and their values are constantly compared by the default values of the following factors and if the values goes higher the threshold value it will notify the government and the required authorities about the bad water quality so that they can solve the issue. Earlier it takes the human efforts to constantly measure the quality of water which wastes a lot of the time of the humans also and the consistency is low in case of humans.

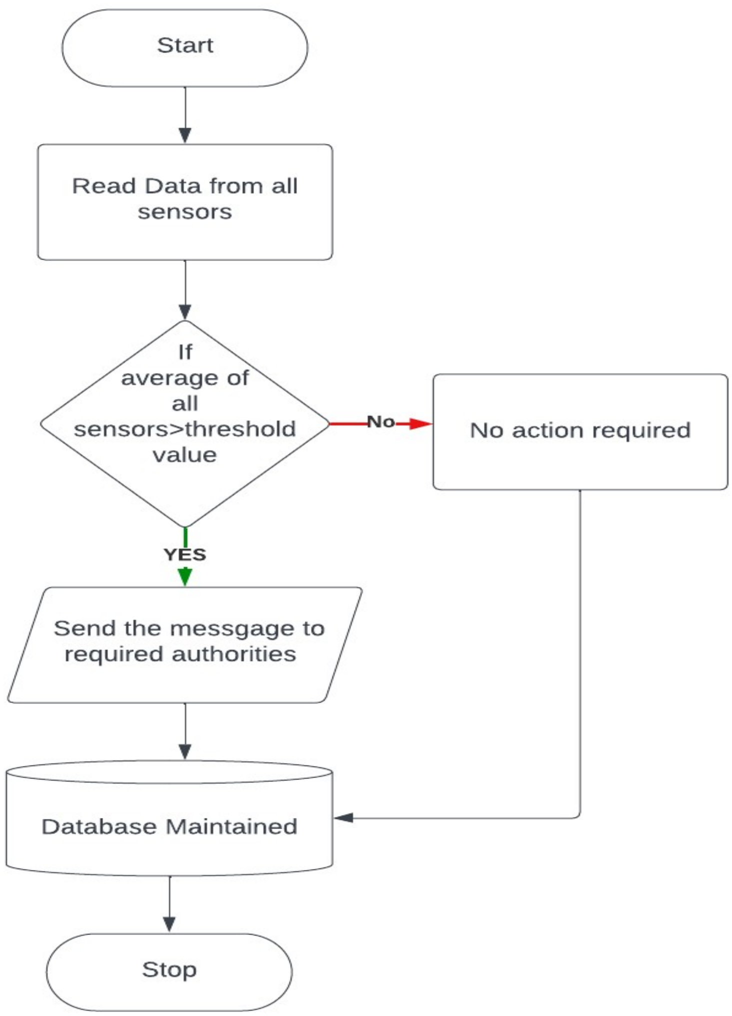

Figure 1 Flowchart of working model

Figure 1 represents the sequence of processes required in this project. Initially the process starts and read the data from the sensors. If the average of all the sensors is above the threshold value, then the message is send to the required authorities. Is not then no action required. In both the cases the database is maintained.

RESEARCH OUTCOME

The outcome of the research is to create a prototype to sense the water quality from the lakes and the ponds of the villages and if quality is not up to the mark then the authorised person will be notified automatically without human intervention.

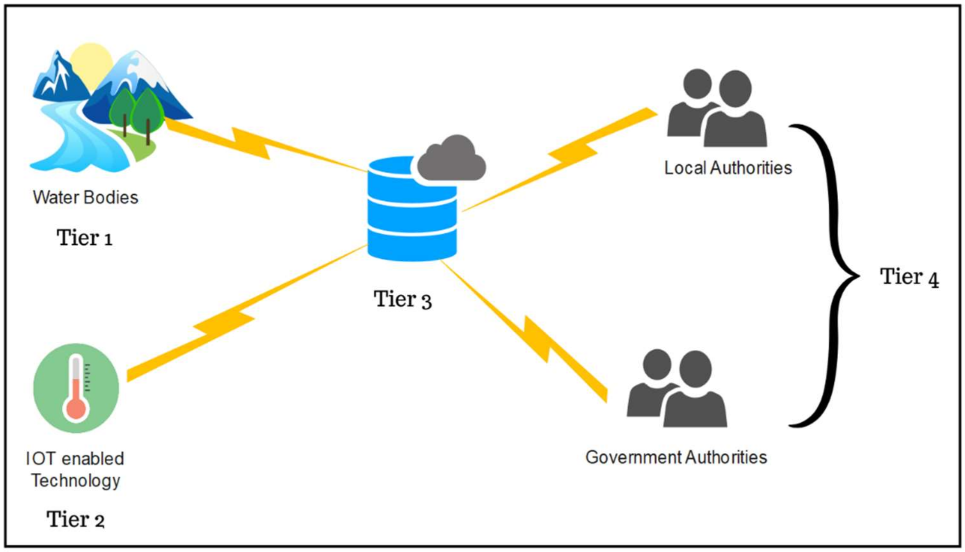

Figure 2 Tier Architecture

In this Figure we divided our system into different tiers. All the components are connected with cloud database as sensors will send the data to the cloud database that is collected from the water bodies of rivers. Think speak will connected to database to show the results in an understandable form. So that we can utilise the data efficiently in future. Local Authorities are also connected with cloud database as they will get notified as water bodies requires some actions.

The detailed outcomes of the paper are as follows:

Proposed Improved Architecture: The paper presents an innovative architecture for water quality monitoring systems specifically tailored for water bodies located near towns, villages, and cities. This architecture incorporates advanced IoT-based techniques for real-time data collection, transmission, and analysis, enhancing the effectiveness and efficiency of water quality monitoring in these critical areas.

Enhanced Toxicity Detection: Through the development and integration of a toxicity detection algorithm, the paper enables the timely identification of water quality issues, such as contamination or pollution, and alerts relevant authorities to mitigate potential hazards. By leveraging machine learning techniques, the algorithm improves the accuracy and reliability of toxicity detection, thereby enhancing public health and environmental protection efforts.

Increased Public Awareness: The paper contributes to raising awareness among the public about the importance of water quality and the potential health risks associated with polluted water. Through targeted awareness campaigns and educational initiatives, the research empowers individuals and communities to take proactive measures to protect water resources and promote sustainable water management practices.

Improved Decision-Making: By providing real-time insights into water quality dynamics near human settlements, the proposed solution enables informed decision-making and prompt intervention measures to address water quality issues effectively. The availability of accurate and reliable data empowers stakeholders, including local authorities and community members, to take timely actions to safeguard public health and environmental integrity.

Validation of Proposed Solution: The research validates the effectiveness and performance of the proposed solution through rigorous testing and evaluation. By assessing the accuracy of the toxicity detection algorithm, the reliability of sensor data, and the responsiveness of the system to detected water quality issues, the research provides empirical evidence of the solution's efficacy and utility in real-world settings.

PROPOSED TIME DURATION

Figure 3 Gantt Chart

Week 1:

Research: Gather information on IoT techniques and water quality monitoring.

Literature Review: Start reviewing relevant literature on water quality monitoring systems and IoT applications.

Week 2:

Continue Literature Review: Complete the review of literature.

Hardware Setup: Set up the Arduino processor and gather necessary hardware components.

Week 3:

Sensor Calibration: Calibrate the pH sensor, LED sensor, chlorine sensor, TDS sensor, turbidity sensor, and temperature sensor.

Data Collection: Start collecting data using the calibrated sensors.

Week 4:

Data Collection: Complete data collection process.

Data Analysis: Analyze the collected data.

Report Writing: Begin writing the research paper, including sections such as Introduction, Methodology, Results, Discussion, and Conclusion.

Final Review: Review and finalize the research paper, making any necessary revisions before submission.

REFERENCES

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