Journal of Information Systems Engineering and Management
2025, 10(20s)
e-ISSN: 2468-4376
https://www.jisem-journal.com/
Research Article

Analysis of Water Quality using IOT

Rajeshri Vaidya[1], A.A. Bardekar[2]
[1]Assistant Professor, CSE Department, Sipna College of Eningeering and Technology, Amravati, Amravati, India
dr.rajeshrivaidya@gmail.com
[2]Associate Professor, CSE Department, Sipna College of Eningeering and Technology, Amravati, Amravati, India
abardekar@rediffmail.com

ARTICLE INFO

Received: 26 Dec 2024
Revised: 29 Jan 2025
Accepted: 18 Feb 2025

ABSTRACT

In an era of increasing concerns about water quality and water health, two revolutionary technologies stand as beacons of hope: intelligence-based analytics and instant Internet of Things (IoT) data distribution with portable water. These test kits measure important parameters such as total dissolved solids (TDS) and pH, while also testing various other water quality parameters. This study highlights the convergence of these changes and heralds a new era in watershed management and water quality assessment. The health of aquatic ecosystems and the safety of drinking water resources are important for the health of our environment and people. As these systems face unprecedented challenges due to pollution, climate change and disease outbreaks, the need for maintenance and inspection of equipment is great. The first part of this study examines networking and artificial intelligence-driven analysis of real-time IoT data in water health assessment. We can continuously measure water level at high resolution using a network of sensors and data collection devices placed in the water environment. The resulting data is sent to a central IoT platform and forms the basis of our research. AI algorithms are then used to identify complex patterns in this data, providing insight into water health. This powerful collaboration promises to revolutionize our understanding and management of water resources.

The second part of this research focuses on water quality testing equipment that can measure TDS and pH while monitoring many other important aspects of water quality. Designed for ease of use and quick installation, these kits offer a simple and fast solution to water quality testing. They combine the simplicity of on-site measurements with the precision of high-pressure measurements, enabling individuals and organizations to make informed decisions about water safety and quality. These two technological advances together create a powerful tool for water conservation and water quality. Not only can they instantly monitor water bodies, but they can also quickly detect and respond to problems, whether in terms of ecological protection or public health. This study examines the process, implementation and impact of this change in depth, providing insight into its real-world application and potential benefits. By leveraging the power of the Internet of Things, artificial intelligence and quality water testing equipment, we are embarking on a journey to a future where water testing is more efficient, convenient and timely than ever before, ultimately supporting the protection and sustainability of our aquatic ecosystems. Sustainability and fresh water.

Keywords: management, water quality assessment, measuring, TDS , pH , monitoring, IoT platform.

INTRODUCTION

Water is the lifeblood of the planet; It is an irreplaceable resource that sustains ecosystems, sustains communities and fuels the economy. Its importance stems not only from its universality but also from its shortcomings. The health of our aquatic ecosystems and the quality of our water resources are increasing due to urbanization, industrialization, pollution and climate change. To effectively solve these problems, we need to improve the ways we monitor, analyze and protect the aquatic environment. This research set out to investigate the connection between two technological changes: the delivery of Internet of Things (IoT) data in real time with intelligence- driven analysis and portable water meters to measure total dissolved solids (TDS).) and pH evaluate various water quality simultaneously.

These innovations have the potential to revolutionize our approach to water health management and water quality assessment. Aquatic ecosystems, whether large oceans, rivers, or small urban lakes, are dynamic and complex networks that support oceans. Life. Their health depends on the health of our planet and human life. But these ecosystems face unprecedented challenges. Industrial and agricultural pollution, habitat degradation, invasive species, and climate change all create negative impacts. Therefore, understanding and managing the health of aquatic ecosystems is important to ensure their importance and our own well- being.

The first major part of this research focuses on integration-oriented analysis of instantaneous IoT data transmission and intelligence. By applying a set of installation plans and data collection tools to the aquatic environment, we can achieve continuous, high-quality monitoring of various water resources. These sensors produce instantaneous data that is sent to a central IoT platform. This is where smart algorithms come into play, unraveling complex patterns and trends in data. The result is a new ability to understand and control water with unprecedented precision and efficiency. The second part of our research is about portable water testing equipment designed to measure TDS and pH while making a complete analysis of water in water. Many other types of water are not good. Designed for ease of use and rapid deployment, these kits bridge the gap between traditional testing and field testing. It enables individuals and organizations to obtain instant, on-site, multi- parameter water quality profiles. This feature is a game- changer that provides instant information about water safety and the environment.

Together, these two technologies create an electronic device that has a huge impact on water management and water quality measurement. Not only do they provide emergency care, they also detect problems.

Whether in the context of protecting fragile ecosystems or ensuring the safety of drinking water supplies, these innovations have the potential for change. This study details the process, implementation and impact of this change. We explore real-world examples and best practices to show the path to water quality change. By leveraging the power of IoT, artificial intelligence, and water quality testing equipment, we envision a future where water quality testing is easier, more intuitive, and faster than ever before. In this process, we hope to contribute to the protection and development of aquatic ecosystems and freshwater for future generations. Water plays an important role in water health and water quality measurements and a change in our approach is needed. Sustain life and ecosystems. This is not just a product; It is the foundation of a successful community, a thriving economy, and a thriving ecosystem. Therefore, understanding the health of water bodies and ensuring the safety and quality of water resources is ethical, ecological and social. The integration of real-time IoT data and AI- powered analytics represents a revolution in our ability to monitor and manage water resources. This change goes beyond traditional methods that rely on material and labor- intensive measures that often fail to capture the complexity and fragility of water resources. We can now measure many organisms in water using sensors in water. Bad water sequence. Temperature, dissolved oxygen, turbidity, nutrient levels, and bacteria are just a few examples of the information these sensors can instantly capture. This valuable information provides insight into seasonal changes, pollution events and seasonality, forming the basis of our understanding of the water column. The role of artificial intelligence in this process cannot be emphasized enough.

Machine learning algorithms can examine large amounts of data and identify patterns and anomalies that humans cannot identify. These algorithms provide a deeper understanding of water quality, enabling critical analysis, prediction of water quality and early detection of problems. At the same time, the water quality testing equipment located in the body represents the change in the freedom of water in the water. Water quality measurement. In the past, obtaining detailed information about water quality required collecting and transporting samples to a laboratory; This process took days or weeks. Get on-site water quality data in minutes with portable devices that measure TDS and pH while monitoring a variety of other parameters. This allows people, communities and organizations to make decisions about the safety of water and the flight environment. The impact of these innovations is far-reaching. They help quickly monitor water health, quickly detecting and mitigating potential problems. Through research and best practices, we show how these tools are making a difference, from protecting fragile ecosystems to access to water and safe drinking.

When we conduct this research, we envision a future where our understanding of water health is more comprehensive, accessible, and timely than ever before. Through the integration of real-time IoT data transmission, intelligence- driven research and water quality testing equipment, we strive to leave a healthy and strong environment for future generations by contributing to the protection and development of aquatic ecosystems and freshwater.

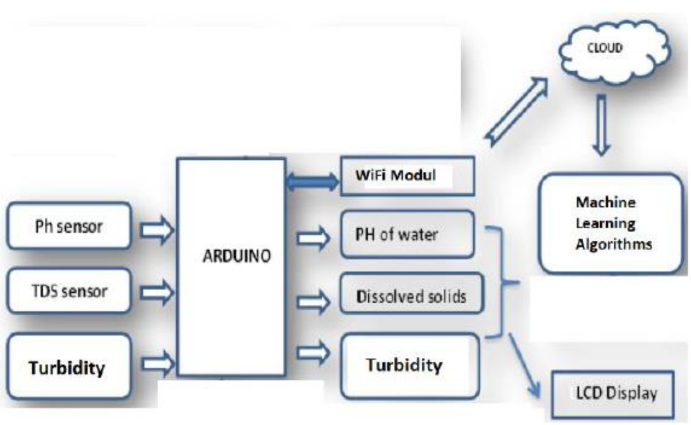

Fig. 1 System block diagram.

METHODS AND MATERIALS

A. IoT-ENABLED FRAMEWORK FOR WATER QUALITY

The proposed IoT-enabled framework has four modules, such as sensing module, coordinator module, data processing module, and decision module. The sensing module consists of temperature, pH, turbidity, and TDS sensors. The coordinator module consists of an Arduino controller and Long-Range (LoRa). The data processing module consists of a database, a machine learning block, and uploading the data to the cloud. The decision module generates an alert if the water quality is beyond the threshold.

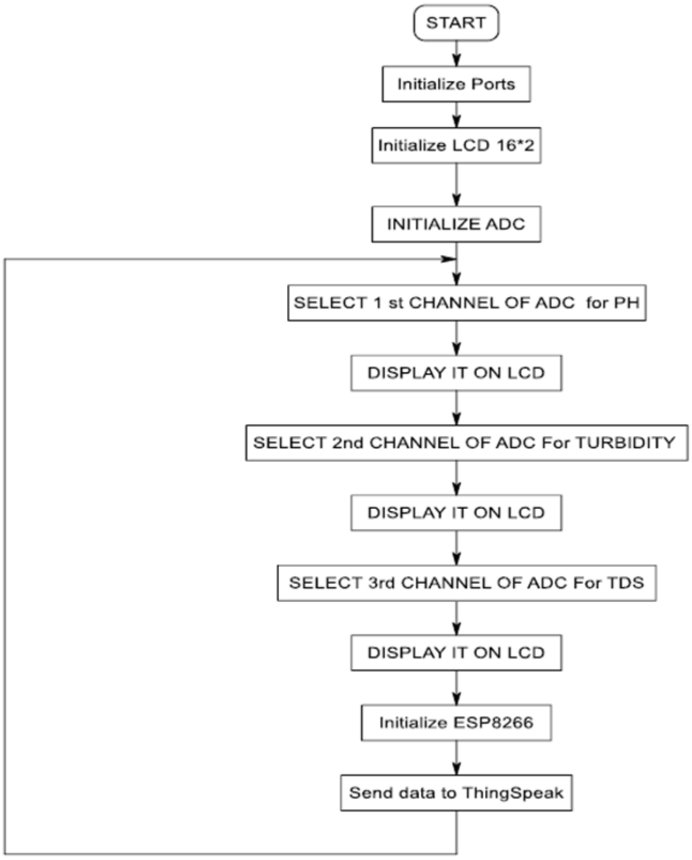

Fig. 2 Flow Chart of Program.

The tasks for each module are discussed as follows.

1) SENSING MODULE

The sensing module is responsible for collecting data on WQPs. In this case, it consists of temperature, pH, turbidity, and TDS sensors. These sensors are deployed in the water bodies to periodically measure the respective WQPs. The temperature sensor measures the water temperature, the pH sensor measures the acidity or alkalinity, the turbidity sensor measures the clarity or cloudiness, and the TDS sensor measures the concentration of dissolved solids. These sensors provide real-time data on the WQPs, they consist of an Arduino with a LoRa module and four sensors. The connection diagram of an IoT is shown in Fig.1

A) pH SENSOR

This sensor measures the acidity or alkalinity of water by quantifying the concentration of hydrogen ions in the water . They provide a pH value that ranges from 0 to 14, with values below 7 considered acidic, values above 7 considered alkaline, and a pH of 7 representing neutrality. The pH sensors employ various technologies, such as glass electrodes or solid-state sensors, to measure pH accurately. They are essential in water quality monitoring as pH affects biological processes, chemical reactions, and the overall balance of aquatic ecosystems. pH sensors are used in applications such as drinking water analysis, aquaculture, wastewater treatment, and industrial processes where maintaining a specific pH range is critical.

B) TURBIDITY SENSOR

This sensor measures the clarity or cloudiness of water caused by suspended particles . They work by emitting light into the water and measuring the scattering and absorption of the light as it interacts with the particles. Turbidity is expressed in Nephelometric Turbidity Units (NTU). Turbidity sensors are important in water quality monitoring as they indicate the presence of sediments, suspended solids, or pollutants. They are broadly employed in environmental monitoring, treatment plants for drinking water, and wastewater management systems to assess water quality, detect changes in turbidity levels, and identify potential issues affecting aquatic ecosystems and human health.

C) TOTAL DISSOLVED SOLIDS (TDS) SENSOR

TDS sensors measure the total concentration of dissolved solids in water . They detect and quantify the presence

Real-time IoT node at deployment location. of dissolved substances, such as minerals, salts, metals, and other organic and inorganic compounds. TDS is commonly represented in milligrams per liter (mg/L) or parts per million (ppm). TDS sensors operate based on different principles, including conductivity or optical sensors. They provide insights into the overall purity and mineral content of water. Monitoring TDS levels is important for various applications such as drinking water analysis, hydroponics, industrial processes, and boiler feedwater treatment. By measuring TDS, potential issues related to water quality and the accumulation of harmful substances can be identified, and appropriate measures can be taken to ensure the safety and suitability of the water.

D) SENSOR ADVANTAGES FOR WATER QUALITY ANALYSIS

The selected sensors, namely temperature, pH, turbidity, and TDS, offer distinct advantages in water quality analysis, collectively contributing to a comprehensive understanding of aquatic ecosystems. Temperature sensors provide real-time information about water temperature variations, which can be crucial for assessing the health of aquatic life and identifying potential thermal pollution. pH sensors enable precise monitoring of acidity or alkalinity levels, aiding in the detection of water bodies' potential vulnerability to pollutants and changes in natural processes. Turbidity sensors play a pivotal role in gauging water clarity, helping identify sediment levels, suspended particles, and potential contaminants that can influence overall water quality. TDS sensors quantify the concentration of dissolved solids, such as salts and minerals, which is instrumental in assessing water's suitability for specific purposes, from drinking to industrial use.

One of the notable advantages of using these sensors is their potential for cost-effectiveness. The implementation of IoT technology enables real-time data collection and transmission, reducing the need for frequent on-site monitoring and manual data collection. This automation leads to optimized resource utilization, as personnel can focus on analysis and decision- making rather than spending extensive time on data collection. Optimization techniques further enhance the cost effectiveness of sensor deployments. Leveraging optimization algorithms, such as genetic algorithms or particle swarm optimization, can aid in determining the optimal locations for sensor placement. This strategic positioning ensures maximum coverage and accuracy while minimizing the number of sensors required. Moreover, these techniques can optimize sensor operation schedules, minimizing energy consumption and prolonging sensor lifespans.

By combining these advantages of sensor technology and optimization techniques, the study not only provides a comprehensive water quality analysis but also offers an economically viable solution. This approach reduces operational costs, enhances data accuracy, and supports sustainable resource management. The integration of sensors, IoT technology, and optimization methodologies demonstrates the potential to revolutionize water quality monitoring by making it both technically efficient and economically feasible.

2) DATA PREPROCESSING

The processing phase holds great significance in data analysis as it plays a pivotal role in enhancing the quality of the data. The acceptable limits for WQPs recommended by the World Health Organization (WHO) for safe drinking water and irrigation purposes are mentioned and are enlisted in Table 1. The data is collected through the IoT system and later is cleaned. After data cleaning, the WQI is calculated using the most significant parameters. Subsequently, water samples have been categorized or classified according to their corresponding WQI values.

Table 1. shows acceptable limits for WQPs set by the WHO

Parameters	Acceptable limits		Unit
	Drinking water	Irrigation	
Temperature	< 25	< 25	°C
pH	6.5 - 8.5	6.0 - 7.5	n/a
Turbidity	1.0 - 5.0	n/a	NTU
TDS	600	< 2000	mg/L

Table 1.

DESIGN AND EXPERIMENT

Circuit Diagram

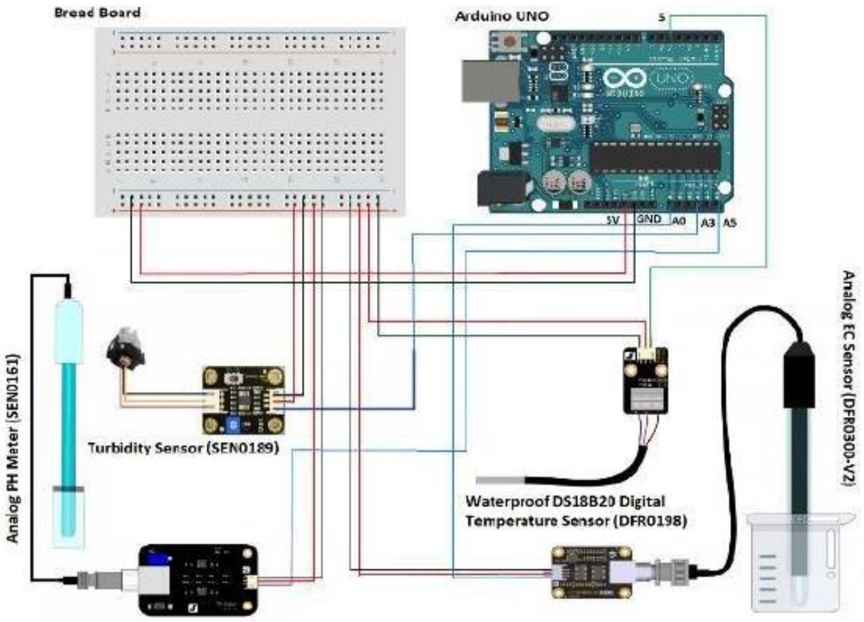

Fig. 3 Circuit Diagram

Circuit Diagram

Fig. 2 shows the schematic circuit diagram of the hardware set-up of the proposed system. Except the temperature sensor, other three sensors are of analog type. Each sensor has three different color wires such as red, black and others. Here, red wires are for +5V power supply, black wires are for ground and others are used for data estimation. A breadboard is used for creating common points for ground and power supply separately. Then common node of ground is connected to the ground of arduino and same process is repeated for power supply. The analog sensors are connected to the analog pins and digital sensor is connected to digital pin of the controller.

RESULT AND DISCUSSION

Water samples are collected from different water sources, and tested to measure the parameters i.e pH, extracted values corresponding four physical parameters for each water sample. Table I shows the analysis of the each physical parameter for 60 samples (83% of data were used for training and 17% were used as test data) divided into three catagories of water sources and indicates their percentage of concentrations not within the WHO standard values temperature, electric conductivity and turbidity for each sample. These water sources are divided into three categories: natural, impure and potable water sources. illustrates the

Figure 4. Collected data for PH parameter.

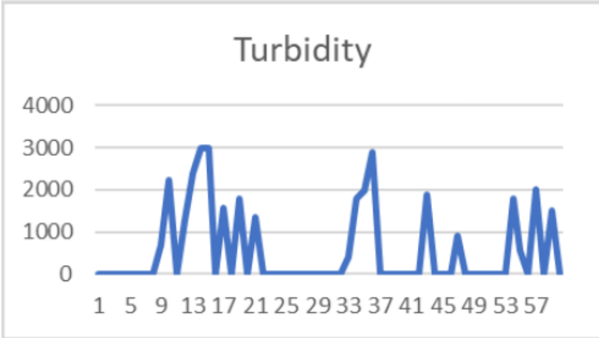

Figure 5. Collected data for Turbidity.

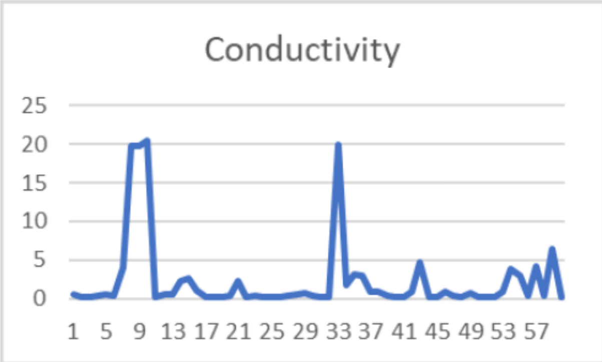

Figure 6. Collected data for Conductivity.

CONCLUSION

The ultimate goal of this work is to observe the quality of water samples by designing a smart water quality monitoring device implemented in IoT platform that can detect four specific physical parameters: temperatures, pH, turbidity and conductivity in water, and analyze the extracted value of these parameters using suitable machine learning approach. Different water samples are tested with the assistance of Arduino based sensors and collected their values of different metrics. Fast forest binary classifier shows better scrutinizing performance to validate the system's accuracy and effectiveness in predicting water quality. The system has shown its importance by providing accurate performance detecting the water quality based on physical parameters

REFERENCES

[1] World Health Organization, WHO/UNICEF Joint Water Supply, and Sanitation Monitoring Programme. Progress on sanitation and drinking water: 2015 update and MDG assessment. World Health Organization, 2015.

[2] R. Ramakala, S. Thayammal, A. Ramprakash and V. Muneeswaran. "Impact of ICT and IOT Strategies for Water Sustainability: A Case study in Rajapalayam-India," Int. Conf. Computational Intelligence and Computing Research (ICCIC 18), IEEE, Dec. 2017, pp. 1-4, doi:10.1109/ICCIC.2017.8524399.

[3] N. Zidan, M. Mohammed and S. Subhi, "An IoT based monitoring and controlling system for water chlorination treatment," Proc. Int. Conf. Future Networks and Distributed Systems, ACM, Jun. 2018, p. 31, doi:10.1145/3231053.3231084.

[4] J. Ramprabu and C. Paramesh, "Automated sensor network for monitoring and detection of impurity in drinking water system," International Journal for Research in Applied Science & Engineering Technology, vol. 3, Jan. 2015, pp. 275-280.

[5] A. A. Pranata, M. L. Jae and S. K. Dong, "Towards an IoT-based water quality monitoring system with brokerless pub/sub architecture," Int. Symp. Local and Metropolitan Area Networks (LANMAN 17), IEEE, Jun. 2017, pp. 1-6, doi:10.1109/LANMAN.2017.7972166.

[6] A. N. Prasad, K. A. Mamun, F. R. Islam and H. Haqva, "Smart water quality monitoring system," Asia-Pacific World Congress on Computer Science and Engineering (APWC on CSE), IEEE, Dec. 2015, pp. 1-6,

[7] S. Geetha and S. Gouthami, "Internet of things enabled real time water quality monitoring system," Smart Water, vol. 2, 2016, pp. 1, doi:10.1186/s40713-017-0005-y.

[8] S. M. G. Nikkam and V. R. Pawar, "ANALYZING WATER QUALITY FOR INDUSTRIAL APPLICATION UNDER IOT ENVIRONMENT," International Research Journal of Engineering and Technology, vol. 3, 2016, pp. 882-885.

[9] S. Sasikala, G. Muthuraman, K. Ravichandran, Water Quality Assessment of Communal Catchments in Tindivanam Taluk, Ind.Chemistry1(2015)106,https://doi.org/10.4172/2469-9764.1000106.

[10] Asheesh Shrivastava, Shalini A Tandon, Rakesh Kumar, Patalganga River Water Quality Shalini A Tandon , Rakesh Kumar, Patalganga River Water QualityManagement Planning for Drinking Water Targets and Human Security, International. J. education. resources. environment. education. 3 (2) (2015) 71–87.

[11] Heinrich Glorian, Hilmar Bomick, Cornelius Sandhu and Thomas Grischek“Monitoring water quality in northern India to identify field water 2018, 10, 1804; doi : 10.3390/w10121804.

[12] Kangabam R. Das, S.D. Bhoominathan, S. Kanagaraj et al. application form. Water Science, 2017, 7: 2907. 7, (6), p. 17. 2907-2918 Ib.

[13] Chadetrik Route, Water Quality Assessment: Yamuna River Case Study,International. J. Earth Sciences. engineer. (2017), https://doi.org/10.21276/ijee.2017.10.0239.

[14] Nayan J. Khound, Krishna G. Bhattacharyya, “Assessment of Water Quality in Jabalali River Basin and Surroundings in the Northern Brahmaputra Plain of India Using Multivariate Statistical Techniques, Applications.” Water Science. (2018) 8:221.

[15] Maltare, N. N., Sharma, D. & Patel, S. (2023). An Exploration and Prediction of Rainfall and Groundwater Level for the District of Banaskantha, Gujrat, India. International Journal of Environmental Sciences, 9(1), 1-17. https://www.theaspd.com/resources/v9-1-1-Nilesh%20N.%20Maltare.pdf