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Monitoring of Water Quality using Machine Learning - A Review

Shashank Y[1], Syed Amith[2], Sahana S[3], Dr. Anitha S Sastry[4]
[1, 2, 3]Students, [4]Associate Professor, Dept. of Electronics and Communication Engineering Global Academy of Technology Bangalore, India

Abstract: The incorporation of machine learning (ML) can improve the monitoring of water quality. It improves the sustainability and security of water resources by enabling forecasting and early detection of possible water contamination. A real-time system that collects information on numerous water parameters, including pH level, dissolved oxygen, turbidity, temperature, and conductivity, is made possible by the combination of IoT technology with ML algorithms. The system models complex links between water quality parameters and looks for variations from typical patterns using a mix of supervised and unsupervised learning and anomaly detection methods. Advantage of this method include cost-effectiveness, scalability, remote accessible, and real-time monitoring.

Keywords: water monitoring, sensors, machine learning, real time analysis

I. INTRODUCTION

By deploying a network of sensors directly in water sources or treatment facilities, an Internet of Things based water quality monitoring system can be developed. Various water quality factors, including pH, temperature, turbidity, and chlorine levels, are continuously tracked by these sensors and data is collected in real time. Following wireless transmission, this data is processed and analysed on a cloud platform or central hub.

Life requires clean, fresh water, however conventional techniques to measure water quality are frequently difficult and site-specific. Here machine learning and internet of things combine to provide an innovative solution.

The system may learn to recognize patterns and irregularities by applying machine learning algorithms through training on previously collected data sets that contain water quality assessments and relevant contamination levels. This makes it possible to predict possible contamination instances and evaluate the water quality in the real time

There are numerous benefits of monitoring water quality while integrating IoT and ML. Continuous monitoring is made possible by real-time data collecting, which accelerates up the recognition of issues. Large data sets can be analysed by algorithms to identify patterns and anticipate problems before they get out of reach. These 10 proactive methods ensure a steady supply of clean, safe water and for prompt intervention.

Water safety has advanced significantly with the usage of machine learning and IoT-based water monitoring devices. Through the provision of accurate data, trend analysis, and problem forecasting, these systems enable us to protect this essential resource for present and future generations

Monitoring water quality is improving as an outcome in large part to IoT and machine learning technologies, which contribute to sustainable practices and well-informed decision-making

All things considered, the tracking of water quality with algorithms related to machine learning offers an effective approach for safeguarding the long-term viability and safety measures of water supplies, thereby helping to maintain ecological balance and public health.

The rest of the section is structured as follows:

In section 2, it consists of the brief literature review. Section 3 & 4 provides conclusion and references

II. LITRATURE REVIEW

The study [1] paper describes an ensuring groundwater purity and maintaining drinking water quality depend heavily on user working together. Pathogens in water are eliminated by disinfectants like fluoride and chlorine, but the impact can be dangerous. A real-time chlorine concentration is monitored using a suggested methodology that use a sensor hub along with a decision tree algorithm. After that, data is transmitted over a communication system for analysis.

Metrics like recall, accuracy, F-score, and ROC serve to assess the value of the model is. The greater precision of the model is illustrated by its ability to predict chlorine material far better than present techniques.

The aim of this paper [2] is to access to clean water is seen as a basic right of human and is necessary for human survival. As water is used by people, mostly from springs and pipes in nearby of towns, contamination, leaks, and loss occur. A potential answer to these problems is provided by IoT and machine learning. Based on these technologies, the authors suggest a method that employs machine learning algorithms for decision-making and keeps track of water quality, loss and waste

The insight of this paper [3]. Even though access to water is essential for survival of human, the environment is harmed by untreated wastewater. Therefore, continuous monitoring of water quality is required to identify the causes of contamination and stop further damage. Monitoring system of water quality was created for this purpose utilizing Arduino technology, which allows data to be collected, sent to MQTT Brokers, and dump in a database. The information is shown on a webpage for monitoring. For backend analysis and prediction, three machine learning techniques—Random Forest, ANN, and LightGBM—were applied. It was got to known that the LightGBM algorithm had the best prediction accuracy for temperature, pH, ORP, and NH3. By utilizing a real-time monitoring and machine learning predictions to make up for the lack of frequent and expensive data collecting

The study [4] focused on water supplies are essential to the environment and human health on a global scale. Improving water management requires accurate forecasting of water quality. To ascertain the effects of water quality and provide a method for robotic water quality evaluation and tracking that can contribute to ensuring the safety of water everywhere in the world. In order to enable competent decision support making in IoT-based smart water quality and monitoring systems within the context of smart cities, this paper gives an IoT-based water quality system in contrast to a successful machine learning-based prediction approach to estimate the water purity at scale. The IoT and machine learning algorithms based on predictions are utilized in this water quality testing and monitoring system. One essential activity of data prediction process is forecasting

The goal of this work [5] is to use machine learning techniques at the edge device which are adaptive to time, location, and applications to intelligently detect worrying events in the water quality. The goals are as follows to create an edge device that is able to measure water quality parameters, use machine learning to detect changes in the water quality with respect to baseline parameters at the edge device itself, generate alarm signals when parameters exceed threshold values and classify various forms of contamination and analyse them to identify potential types of contamination. Weighted Arithmetic Index, NSF Water Quality Index, and user feedback on the water quality are the three indicative approaches for quality of water that are employed in the experiment. Six physio-chemical sensor parameters are biological oxygen demand, total dissolved solids, dissolved oxygen, pH, total hardness, and turbidity are used to calculate the Water Quality Indexes (WQI). The SVM algorithm has been used to create a lightweight model that is appropriate for edge devices with the aid of WQI of these techniques. To identify different kinds of concern incidents, we additionally clustered the events

Applications based on the IoT [6] are quickly replacing human-driven systems. The fundamental benefits such as process automation, have motivated researchers to suggest new Internet of Things applications in diverse fields, helping to save valuable resources and save labour costs. The literature that is now available highlights creative water monitoring methods, but additional work is necessary to effectively use the data from water sensors. Initially, a unique IoT-enabled water management system for long-term data gathering and analysis is proposed in the research. We use statistical techniques and ML to identify valuable trends from actual water consumption records based on the collected data after system deployment. These trends include identifying abnormalities in the data, forecasting future water demands, identifying the source of water waste, identifying data abnormalities and analysing how the environmental factors affect water consumption. Additionally, a subsystem to regulate water usage is suggested in this research. With the introduction of different propulsion trains, new vehicle components that need maintenance are also introduced. The monitoring of batteries is essential for all-electric, hybrid, and fuel cell cars in particular.

This paper describes [7] that, the challenge is getting access to a sustainable and secure water source, especially in developing nations' rural areas. To assure clean drinking water, monitoring has been used in a many of water resources. On the other hand, manual safe monitoring drinking water is known to be time-consuming and costly in terms of operation and transportation. With the use of an Internet of Things framework, this work provides a system for classifying potability and monitoring water quality. Portable sensor nodes are placed in various rural domestic water sources to collect data on the physicochemical characteristics of the water. Real-time wireless transmission of data gathered by nodes to a base station is occurring. The station uses ensemble learning to classify potability.

In addition, the base station uses 2G/3G connectivity to communicate the grouping result to households. Additionally, a cloud server receives both the actual sensor data and the expected result for remote monitoring through a web interface.

This study [8] proposes an automated system designed to analyse real-time data obtained is deployed in a city's water distribution infrastructure. The system's primary goal is to check water quality and generate alerts as needed. Water quality measures include flow, pH, turbidity, free chlorine, nitrate, and fluoride. The distributed system initially processes sensor input, providing many visualizations that synthesize vast volumes of information. These representations allow for real-time monitoring of the sensor's status. Additionally, citizens can receive notices on any potential faults in water distribution network via WhatsApp messages. By resolving the constraints of standard monitoring methods, this technology helps to improve public water supply services significantly.

This study [9] is to monitor and preserve the sustainable environment for carp fish species in fishing ponds using dispersed machine-to-machine communication. Fish aquaculture is classified into three types: marine, brackish water, and freshwater aquaculture. Maintaining water quality in inland aquaculture poses an important difficulty. Carp is the famous inland farm fish; hence it serves as the research's main focus. The suggested aquaculture fish feeding system utilizes IoT technology to automate the feeding process based on recorded carp fish behaviours. Sensors (Ph, Temperature, and Turbidity) collect data on environmental factors such as water temperature and fish feeding patterns to optimize feeding and overall fish health. The obtained data is used to make machine learning predictions, which are exhibited through a React Native mobile app and a web-based dashboard.

The study focuses [10] on the significance of intelligent water distribution systems in smart cities to fight water scarcity. IoT-based monitoring systems can improve water management by reducing leakage, theft, and overflow. However, the increasing amount of communication and sensing devices in smart cities has resulted in increased delay and energy usage. The paper proposes solutions for effective delay and energy offloading in IoT-enabled water distribution systems. It makes use of various IoT-enabled communication network topology models taking account of water network design features land cover patterns, and wireless channels. The ideal communication network architecture for continuously monitoring a water distribution network in a secondary metropolitan city in India has been discovered. Based on the study, increasing the number of states in the state transition diagram may be beneficial.

The primary objective of the paper [11]. The important components for life as we know it is water. This paper presents a system for monitoring quality of water and informing consumers to pollutants. Many numerous substances may pollute water. When determining how to clean the water, these factors are taken into consideration. The system uses machine learning techniques and the IoT. The chemical and physical sensors that measure conductivity, dissolved oxygen, colour, pH, and turbidity to determine influencing factors. After having been saved in a database, the sensor-collected data is sent for analysis. The outcome is anticipated using the neural network method. It's employed to produce a nonlinear relationship for the anticipated outcome. The system notifies the user of an alarm when the parameters drop below the default values. This gives the user to anticipate water pollution in their home tanks. This approach can be utilised in businesses and water treatment facilities in residential tanks.

In light of four parameters are pH, electric conductivity, temperature and turbidity. This study [12] describes a SWQM system that is based on the Internet of Things. To find the water parameters, an Arduino Uno is separately paired to four sensors. The sensors' extracted data is sent to a desktop built on the NET platform, where it is contrasted to WHO norms. The suggested SWQM can efficiently utilize a rapid classifier called forest binary to assess the parameters and determine the possibility that the water is drinkable correspondingly to the measured results.

Sustainable solutions [13] represent the next wave of approaches to monitoring and managing precious natural resources, like water. Smart IoT-based water monitoring and management system designs which are subject of research for many applications, including the residential, commercial, industrial, and energy sectors. In order to achieve this, in contrast to other surveys found in the literature, this work offers a comprehensive analysis of 43 articles for water management and monitoring systems suggested in four distinct sectors: residential, industrial, agricultural, and oilfield. To fill a vacuum in the literature, we also suggest a novel optical management system in this work, especially for oilfield operations that need large volumes to boost oil production. The system senses and transmits gathered data using an advanced optical method. Taking these things into consideration, this work offers a unique manual for more research aimed at incorporating IoT in the area of water monitoring and management.

The scope of this paper [14] is, to regulate the levels of contamination in household water supplies, urbanization has created a demand for efficient monitoring and notifying water body maintenance officials.

Conventional techniques are expensive and time-consuming, such as taking samples from tanks and dams and sending them to labs. This study suggests an embedded systems and Internet of Things-based real-time water contamination monitoring system. Equipped with an Arduino Uno, an ESP 8266, an analogy to digital converter, pH, turbidity, and temperature sensors, the system assesses the quality in private homes and water body tanks. The ESP8266 WIFI module then transmits the data to a ThingSpeak cloud server, where it is processed and evaluated online. The outcomes may be used to ascertain the water sample's quality for testing. For automated water quality monitoring, this approach achieves intelligence in data processing and socializing information transfer, providing efficiency, accuracy, and economical use of personnel and material resources.

III. CONCLUSION

Finally, combining IoT technology with machine learning strategies in water grade monitoring systems is a big step forward with numerous advantages. Real-time data collection becomes smooth with the deployment of IoT sensors, enabling a thorough understanding of water quality parameters such as pH levels, dissolved oxygen, turbidity, and pollutants. Machine learning strategies, when combined with this plethora of data, have exceptional predictive capabilities, allowing for early detection of anomalies and potential water quality issues. This approach enables allows for timely response, reducing hazards to public health and environmental integrity. Furthermore, the scalability and versatility of IoT-enabled systems make them adaptable to a variety of situations, ranging from urban water supply networks to distant rural settlements. In addition, the continual cycle between gather data, analysis, and system design promotes continuing increases in accuracy and efficiency. However, difficulties such as data security, interoperability, and algorithm reliability must be addressed as a way to improve the reliability and value of these systems.

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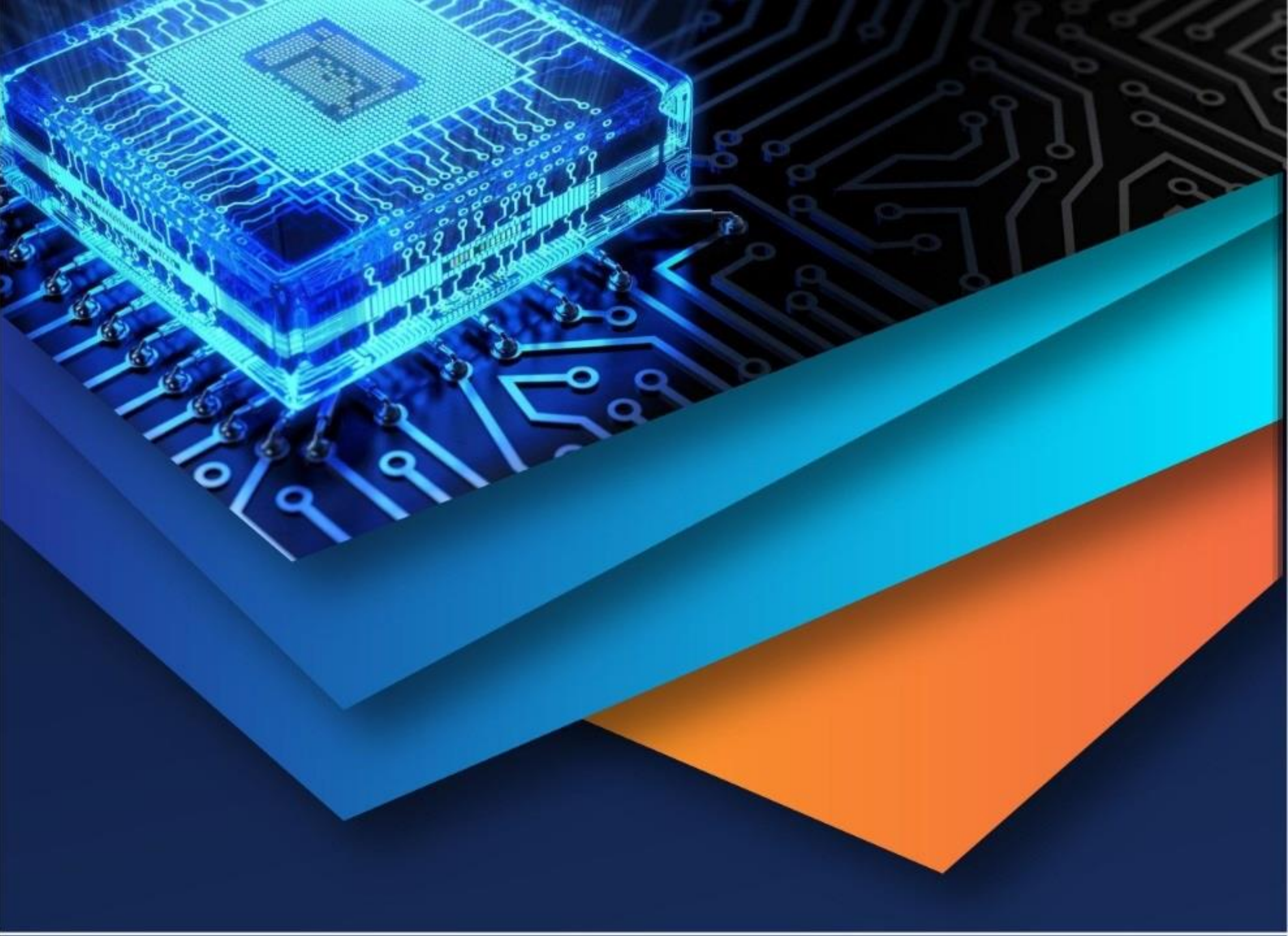

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