Monitoring water parameters using IoT technology

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Abstract

Rivers are one of the most important sources of water for agriculture, industrial use, and other applications. The river systems are particularly exposed to the negative effects of pollution due to their dynamic nature and easy accessibility for waste management. The concept "water quality" *refers to the state or condition of a body of water, taking into consideration its chemical, physical, and biological aspects. The importance of measuring the water quality parameters for studying any aquatic system cannot be overstated. Indirectly, increasing the rate of water pollution will affect agriculture, leading to a decrease in the quality and quantity of vegetables and fruits grown. The objective of the article focuses on water quality determined by the analysis of the values of some parameters such as salinity, pH and conductivity. This article is based on the SWAM project's study, which intends to provide a strong and flexible platform through which humans can discover the reasons their health is affected by low water quality. The parameter monitoring system is based on IoT technology, the data being collected by sensors and then transmitted via an MQTT protocol to a Cloud database where it will be stored and processed. The results obtained from the parameter analysis were optimal, with the data collected not being drastically affected by the external environment. The presented study differs from other research due to the experimental data interpreted in a different way and the monitored parameters, the article being based on the evolution of pH, conductivity and salinity and how these parameters evolve in two weeks.*

Keywords: *IoT, MQTT, conductivity, salinity, pH*.

1. Introduction

The world population has tripled in the last 66 years, from 2.5 billion in 1950 to 7.5 billion in 2016. This global population growth has affected the environment, namely three important factors of our livelihood: water, air and land. In the last year, according to statistics, there have been more than 600.000 thousand deaths due to water contamination causing health problems and developing infections transmitted through drinking water. If cautious procedures to monitor water quality were adopted, these problems might be avoided.

The growth of IoT technology in this industry will increase its long-term viability and profitability while also allowing it to respond to digitalization. Aquaculture is all about water quality, and mastering it is the key to success. Related work will include some methods presented in several articles for monitoring the parameters that show the quality of water. Parameters like pH, salinity, turbidity, conductivity and dissolved oxygen are of interest in the following article. The evolution of the parameters will be presented over a period of two weeks. The architecture of the system consists of four layers, and each layer had an important role.

The article is organized as follows: Section 2 describes the current state of the art of the article that gives a brief history of IoT technology used to monitor salinity, pH and conductivity. The next section presents the design architecture of the model used in this article. Section 4 focuses on the experiments performed and the results of using this prototype. Furthermore, the article summarizes the conclusion in the end.

2. Related work

In the article [1], the system about water quality is solved with flow rate measurement while also proposing a strategy for preventing water waste. It can measure the quality of water delivered to each household through the deployment of sensors. Where there is a need to have safe water and minimize water loss, the suggested IoT system can be utilized for verifying the level of pH and conductivity of water. Thus, when the pH and conductivity values are not in the predefined safety range, the valves of the reservoirs that supply water to households are blocked.

The authors of [2] provide a solution to the challenge of real-time water quality monitoring. The system is developed with the help of the WeMos D1 mini and sensors (temperature, pH and turbidity). The WeMos D1 small is an Arduino-style board with built-in Wi-Fi for sending sensor data over the Internet. The whole experimental setup for water quality data gathering, online data transfer, monitoring, recording, and analysis is created and tested. It is noted that the system changes its settings in less than a minute. This low-cost solution is ideal for residents, as well as businesses looking to check water quality.

The article [3] describes a sensor-based water quality monitoring system. A microprocessor for system processing, a communication device for inter node communication, and multiple sensors are the essential components of a Wireless Sensor Network (WSN). Access to data collected with sensors is achieved through remote monitoring and IoT technology. This data is displayed in a visual format via a PC server using Spark MLlib streaming analytics. Afterwards, they are compared as follows: if the measured value is higher than the threshold value, the user will receive an SMS alerting him that something has happened. This unique system brings a breakthrough in water quality in Bangladesh as it will closely monitor substances that pollute drinking water, and it is also a low power, high mobility system.

The article [4] highlights a new water monitoring system for rivers, lakes and coastal areas at a minimal cost. The underlying components of this system are commercially available electrochemical sensors, a microcontroller, a wireless communication system and a custom beacon. The system detects water pH, dissolved oxygen and water temperature within a given time frame. Through a web portal the collected data is imported into a graph and a table. The stability of the beacon is tested in harsh environmental conditions. The results of the system prove its effectiveness in monitoring water quality.

The article [5] provides a review of the application of IoT for real-time water quality monitoring and the creation of prediction systems in an aquaculture scenario. The capability to anticipate the evolution of water parameters is allowed by the creation of a wide variety and significant volume of data. As a result of the Internet of Things' contribution to Artificial Intelligence, aquaculture may take the technical leap required to expand while maintaining an environmental sustainability goal. The system is used on farms and is designed to monitor water quality parameters such as salinity, dissolved oxygen, conductivity, pH. The monitoring device consists of an electronic card, an antenna, water quality sensors, solar panels, rechargeable batteries and a LoRaWan module. The system used allows the integration of monitored data into algorithms to predict the quality of water by estimating factors that influence a change in water quality.

In article [6], the water quality of the Krishna River is analyzed by monitoring various parameters such as conductivity, dissolved oxygen, temperature, pH. The system uses IoT technology to collect data and interpret measurements to perform a more detailed water quality analysis. This system includes the following devices: Arduino Mega 2560, Wi-Fi module - ESP 8266, together with pH, temperature, conductivity, dissolved oxygen sensors. The data is effectively used to assess the water quality of the Krishna River using one-way ANOVA, which analyzes a specific parameter and predicts the rate based on the value obtained.

The article [7] presents a new technology based on an IoT system that monitors the quality, especially the pH of water from drinking water reservoirs. The data is sent to the authorities to inform them about the level of pH. This system uses a GSM module for transmitting the messages and an Arduino board for finding the pH level. For visualizing data, it uses a led display.

The problems presented in the article [8] show the degradation of water resources and air pollution. To solve this problem, it uses a technology based on IoT and several sensors which monitor some parameters which show the quality of water like temperature, pH, turbidity, dissolved oxygen. The collected data from the sensors are transmitted by using a microcontroller. The ADC in the controller converts the measured data to digital and sends it to a GPRS module attached to the microcontroller through the UART protocol. The information collected is forwarded to a server via GPRS and to the end user.

3. Architecture

The main purpose of this approach is to create a Smart Water Management platform that can monitor, alarm and provide technical solutions to improve water quality.

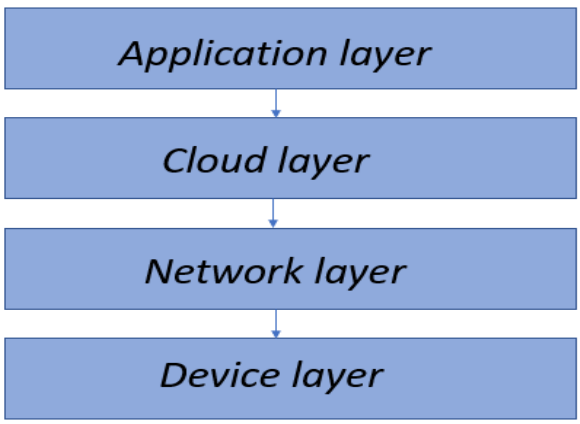

Fig. 1. SWAM Architecture

The architecture presented in Fig. 1 has four levels, each of them having an essential role in having a better performance. The levels are: Device, Network, Cloud and Application.

3.1. Device Layer

This layer is characterized by several sensors for monitoring water parameters such as conductivity, pH, salinity (Table 1). The sensor information is collected by a microcontroller and is processed to reach the network layer. The PHEHT sensor was used for water pH measurement with high accuracy and a high-speed response time. A single sensor called CAE was used for salinity and conductivity measurement, which has an impressive accuracy because it is made of two graphite and two platinum electrolytes.

Table 1. Parameter of interest for water

Parameter	**Sensor**	**Measure Unit**
Conductivity	CAE	mS/cm
pH	PHEHT	pH
Salinity	CAE	g/kg

3.2. Network Layer

The Network layer consists of an HAN, which is a tiny network that assures communication between two components, whether wired or wireless. NAN is the solution responsible for transmitting data from the gateways to the concentrator. The WAN is responsible for transferring data from the concentrator to the different zones.

3.3. Cloud Layer

Any IT services provisioned and accessible through a Cloud Computing provider are referred to as Cloud services. This is a broad phrase that encompasses Cloud Computing and related solution delivery and service methods. Using a Blockchain component that secures the water supply, this platform analyses data collected from sensor probes, then stores and processes it to improve water quality.

3.4. Application Layer

This data is analyzed using maps, notifications, or warnings sent to users if problems with the water quality are detected. A time-series database, called Influx DB, is used to store a more significant amount of data, which is analyzed in real-time. This system may be customized to meet the needs of the user. Furthermore, the platform is protected by cutting-edge technology.

4. Experimental results

For two weeks, several experimental measurements were carried out and the evolution of the parameters of interest was monitored.

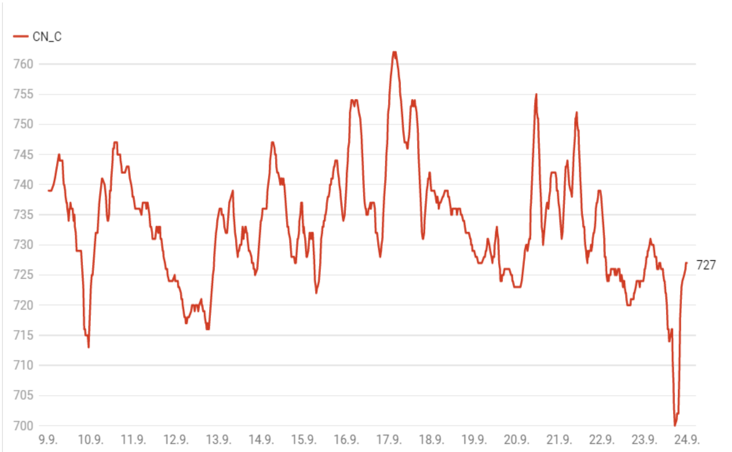

Fig. 2. Water Quality - Conductivity evolution - 09.09.2021 - 23.09.2021

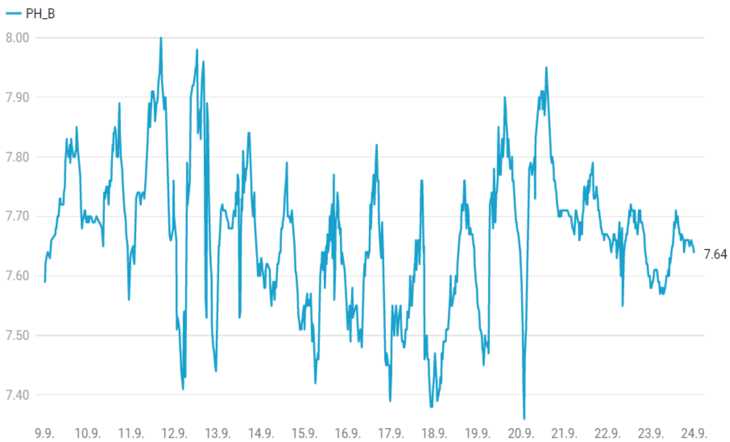

Fig. 3. Water Quality - pH evolution - 09.09.2021 - 23.09.2021

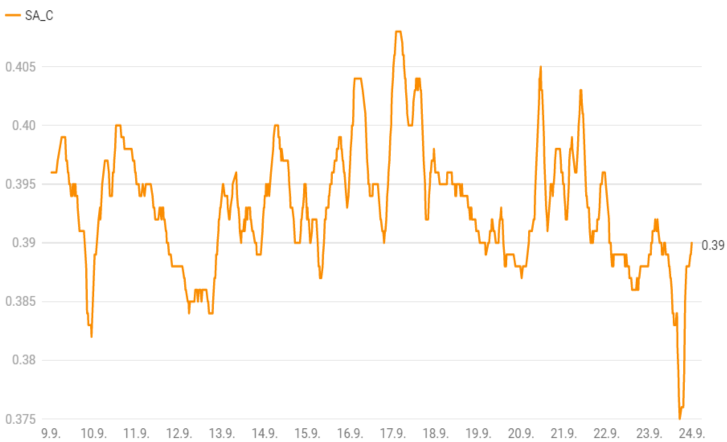

Fig. 4. Water Quality - Salinity evolution - 09.09.2021 - 23.09.2021

In Fig. 2, it is presented the evolution of the conductivity values for two weeks. Following the analysis of the conductivity over the days, it was found that the highest conductivity value was 762 μS/cm, which was recorded on a rainy day. This value was recorded on 17.09.2021 at 02.45 a.m. During the night, the temperature was 17 °C and during the day, it was 29°C. Fig. 3 shows that over the two weeks, the highest pH value was 8.00 pH, recorded on a sunny day. This value was recorded on 11.09.2021 at 04.30 p.m. During the night, the temperature had a value of 11°C, and during the day, a value of 28°C. Fig. 4 describes the evolution of salinity for two weeks. The highest value was measured on 17.09.2021 at 02.30 a.m., with a value of 0.408 ppt. Precipitation was presented and the temperature recorded during the night was 17°C and during the day 29°C.

5. Conclusions

This paper presents an ingenious method to monitor water quality parameters using IoT technology. This research proposes to monitor the characteristics of water to improve the quality of life. The system has a larger number of sensor probes for water monitoring, but for this research, it was chosen to focus all attention on experimental data related to pH, conductivity and salinity.

Acknowledgements

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