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Review Article

The Water Monitoring System's Disadvantages

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Abstract

One of the most significant factors affecting human existence is water quality. Purity tests for the water must often be performed immediately. There will need to be testing at multiple locations if the area to be studied is large. Continual assessments of the water's quality will be difficult and time-consuming. Consequently, a real-time monitoring system is needed to safeguard the water and keep track of its condition in order to stop contamination. Environmental sensors are used to monitor and display the water quality, LoRa technology (Long Range) is a collection of wide-area communication technologies, the Node-RED application, and superior obstacle occlusion and longer signal propagation lengths. It involves tracking and gathering data on variables including climate, electrical conductivity, pH, air pollution, and turbidity that affect water quality. The sensor data is processed by the microcontroller used in the study before being wirelessly sent to the database structure, where it may be viewed on the Node-RED display. The IoT-based monitoring system includes both the Node-RED dashboard and real-time water quality monitoring. The system's merits and drawbacks are explored in this study's discussion of the materials and implementation approach.

Keywords: LoRa technology, Water quality, Internet of things, Node-RED Application, Microcontroller

INTRODUCTION

Water is a natural resource that is crucial for human usage. There are approximately 326 million trillion gallons of water on Earth. Freshwater makes up less than 3% of the global water supply, and more than two-thirds of it is frozen in icebergs and glacier peaks. Despite being a naturally abundant resource, just 0.04% of it may be used [1, 2].

Surface water sources, such as rivers, canals, waterfalls, dams, and reservoirs, and groundwater sources are the two basic types of freshwater sources. Additionally, industrial and agricultural operations are growing swiftly and have a significant impact on environmental toxins as a result of waste generation and chemical leakage. It is crucial to guarantee the safety and usability of water resources. Due to increasing globalization, there are problems with water contamination and demand around the world. Water quality must be closely monitored to avoid any problems caused by water consumption from various activities. Water quality parameters can be divided into three groups. Physical traits like electrical conductivity, turbidity, chromaticity, warmth, smell, and color are included in the first group. Chemical elements such as pH, dissolved oxygen, chemical oxygen demand (COD), biochemical oxygen demand (BOD), complete inorganic carbon, heavy metal ions, and nonmetallic poisons are included in the second category of chemical attributes. The third category, known as microbiological, includes all bacteria and coliforms [3]. It is a laborious and time-consuming process to hand collect water samples from various areas in order to analyze them for quality. Therefore, Internet of Things (IoT) technology, a modern approach, is of interest to researchers for use in assessing water quality. Network-connected devices and, more recently, the value chain that comes from the connecting of things, data, people, and services are both referred to as "IoT" in the same sentence. These and other IoT devices all run on accumulators, thus their sensors need to be connected to the network. In addition to communication, the IoT currently makes a substantial contribution to data monitoring, recording, storing, and displaying. IoT systems create new opportunities for locating affordable resources [4]. IoT technology has been used more frequently in recent years to address environmental issues like poor air quality, water pollution, and radiation exposure [5-7]. According to recent studies, they have used IoT technology to provide real-time monitoring in order to streamline operations and more effectively regulate water quality. Because of their adaptable and dependable technical characteristics, as well as their ability to achieve long communication distances with little power consumption, cost-effectiveness, and fast data transfer speeds during system deployment, LoRa and LPWAN technologies are frequently used in IoT systems [8–11]. For the adoption of LoRa technology, however, zoning regulations or national considerations are required. This is because LoRa devices must be utilized in each country at the assigned frequencies [12]. Finally, in order to use roller technology, users must know how LoRa technology works. This guide will help you choose the right equipment. Therefore, the primary goal of this study was to design and evaluate the effectiveness of a water quality monitoring system for community use that was mounted on a robot (boat) and used Internet of Things detectors to ascertain parameters related to water quality like temperatures, electrical conductivity, pH, air purity, as well as turbidity with LoRa wireless communication. Node-RED technology was also used to display data on water quality.

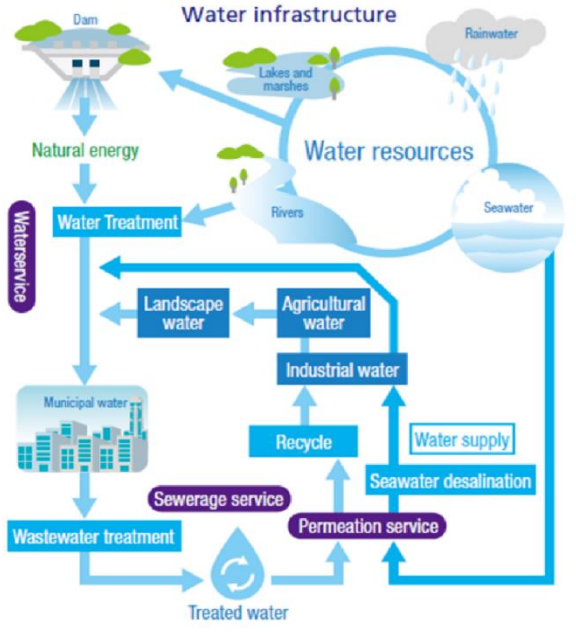

Fig._1: Water Quality Monitoring System

Methodology

In this article, the author tracks a variety of water quality indicators, such as temperature, turbidity, electric conductivity, pH, and air quality, using IoT technology. A TTGO T-Beam controller, a DS18B20 temperature sensor, a TDS conductivity sensor, a turbidity sensor, a pH meter, and a MQ-135 gas sensor serving as an air quality sensor are all included in the apparatus [31–33]. To overcome the constraints of traditional water quality monitoring devices, data is transferred by LoRa and shown on a computer using the Node-RED dashboard. Data on water quality is shown on the Node-RED dashboard once every second for each of those several metrics. This information may also be immediately delivered to the Node-RED dashboard for real-time monitoring [30]. The IoT architecture is a framework made up of physical components, technical network setup and configuration, operational protocols, and data formats. The implementation of IoT architecture may appear extremely different. Therefore, open protocols need to be flexible enough to handle a variety of network applications. The most conventional and widely used structure is three layers. In the beginning of this IoT inquiry, it was used. The three layers stated are perception, network, and application [13]. At the perception layer, sensors are connected to the network layer by a microcontroller board. Using a microcontroller board, the researchers created a sensor monitoring system for this study that measures the temperature, conductivity, pH, turbidity, and quality of the air before transmitting the data using LoRa technology. Devices can talk to other devices thanks to LoRa technology. The data is delivered to the microcontroller board, which then processes it [14]. All of the sensor readings are displayed in the Node-RED application, which users may access from their computers. A collection of wide-area communication technologies known as LoRa (Long Range) provide improved obstacle occlusion and longer signal propagation distances. It runs without a license in the radio frequency bands at a frequency below 1GHz (920-925 MHz in Thailand) and can be used for transmission-related applications. LoRa can provide long-range transmissions of more than 10 km in open-area testing when used in challenging environments. A radius of less than 1 km is the maximum for transmission. The study's research of LoRa performance took the Doppler effect, which affects signal reception, and comparable speeds into account [15]. It was determined that the communication might not work depending on the hardware configuration chosen. Additionally, it completed coverage of both land and ocean. Lora and Lora WAN are the two versions of LoRa technology now in use. This will involve unlawful use of Lora in a certain frequency range. The primary method of communication between each LoRa active node will be point-to-point. Although the service area is constrained, Lora WAN facilitates connection between LoRa nodes and distant end nodes via LoRa gateways, allowing the network to provide long-distance communications on par with those of a WAN network [3, 16]. The Lora WAN communicates via Media Access Control Protocol (MAC), the top layer of the physical layer. In North America, 868 MHz is the most often utilized frequency range, followed by 915 MHz and 433 MHz in Europe [17–19]. The utilization of sensors to measure metrics related to water quality and wireless transmission of that data utilizing LoRa technology are the core concepts driving this project. It has a transmitter and a receiver as its two halves. A TTGO LoRa32 development board and sensors that collect data on water quality indicators from water sources make up the transmitter. The data is transmitted to the receiver using the TTGO LoRa32's LoRa communication function, who subsequently receives the water quality data and displays it on a Node-RED application. An IoT sensor network is integrated with a microcontroller known as the TTGO T-Beam ESP32 to track environmental factors. In addition to enabling GPS connectivity, the EPS32 microcontroller also uses LoRa modules to operate in the 868/915 MHz range. This component will be in charge of sending, receiving, and processing the sensor data prior to presenting it to the application layer. The temperature detector (DS18B20 Arduino) measures the water's temperature in degrees Celsius (°C) with a temperature precision of 0.5°C. The operative temperature range is -55 to 125°C, with an accuracy of -10 to 85°C [20]. The temperature sensor was calibrated at various temperatures using a thermometer. The test results showed that the temperature sensor's accuracy was 94.05%. The temperature of the water is a key factor in deciding if a particular supply is fit for human use and consumption. It also affects oxygen levels for a variety of aquatic animals. The water should be kept between 20 and 30°C, according to the World Health Organization (WHO) [21]. A total dissolved solids (TDS) sensor is a device for measuring a liquid's electrical conductivity or the amount of TDS in water. In order to measure how well water conducts electricity when there are dissolved inorganic materials, micro-Siemens per centimeter of water (S/cm) units are utilized. Effects of water conductivity on the ability of aquatic animals to survive and reproduce High conductivity values have the potential to cause conflict and other undesirable effects [22]. Analyzing electrical conductivity on a frequent basis is necessary to maintain the water's purity. The TDS sensor used in this study is suited for experimentation because it has a measuring range of 0-1000ppm and an accuracy of 10% of the total scale. The pH sensor, commonly referred to as an analog pH meter, is a tool that measures both the pH and the acidity and alkalinity of any solution. It is widely used in many applications, including aquaponics, aquaculture, and environmental water testing. The pH sensor is frequently designed to produce a value between 0 and 14 as needed, according to the negative logarithm of the hydrogen-ion concentration. The formula for pH is pH = -log [H+]. Within the usual pH range for human existence, the pH range for ingestion in this instance should be between 6.0 and 8.5 [4, 23]. In this study, a pH meter was used to calibrate the pH sensor. What is is Mettler Toledo S210. The electronic pH measurement probe's accuracy is calibrated using the pH calibration powder. The pH sensor has a 96.95% accuracy rate, per the test findings. The turbidity sensor is used to determine the turbidity of the water. To find suspended particles in water, it examines the light's transmittance and scattering rate. This rate changes depending on the quality of the total suspended solids. (TSS). The most frequent range for measuring water turbidity is thought to be between 0.1 and 1000 Nephelometric Turbidity Units. (NTU). River water turbidity can exceed 150 NTU [24, 25]. The sensor employed in this study captures the light that is bent by water and converts it to an analog output turbidity value of 0-4.5 volts with a measuring precision of 500ms. Turbidity was compared to 0-1000 NTU using volts. The turbidity sensor was calibrated using standard values. The accuracy of the instrument was found to be 91.03%. The MQ-135 gas sensor is an air quality sensor from the MQ series that can measure and detect a variety of gases, such as smoke, nitrogen oxides, ammonia, carbon dioxide, benzene, and alcohol. The sensor functions by altering its resistance as a result of absorbing these gases. Its main duty is to monitor the air quality by keeping an eye out for these gases. The sensor is made up of an aluminum oxide (Al2O3) ceramic tube, a heating coil, and a tin oxide detecting layer. The analog TTL is compatible with the majority of microcontrollers because it runs on 5 volts [26]. Node-RED allows for the integration of hardware parts, internet services, and application programming interfaces (APIs). By enabling developers to connect devices to APIs using a customizable web browser, it promotes more flexible working practices. Installing Node-RED on personal computers is recommended to ensure the platform's security and privacy. This application is highly well-liked because of its graphical user interface [27–30]. It is also a powerful tool for developing IoT apps with visual programming. The current study implements gauges, charts, serial connections, functions, and switches and uses them to show data from sensor information using the Node-RED dashboard module. To monitor the quality of water resources, a wireless electric boat-based prototype of a mobile water quality collector has been created. The fuel cell used in this investigation has the following measurements: 280 mm wide, 175 mm high, and 880 mm long. The TTGO T-Beam ESP32 microprocessor and LoRa technology enable the mobile collector to have all the sensors needed to measure the water quality. The mobile collector is used to monitor water meters and assess the equipment's condition by using LoRa to broadcast meter reading instructions and data. Better water quality measurements are made possible by the SWQM system the authors have created, which is based on the IoT. The five elements of water quality are temperature, conductivity, pH, turbidity, and air quality [34].

Disadvantages of a water monitoring system

1. Pesticides may still be present in water after washing
   Pesticides are routinely used on farms and nurseries, which puts them at danger of being released into water supplies that may not have been thoroughly treated during purification. Only public water can be used to treat a defiled well, so it must be tested for pesticide contamination. Using home water filtration systems and controlling pesticide use may not always be as effective. These systems can help with the removal of mercury and other heavy and unusual metals like chlorine. The ocean dolphin dominates the field of water filtration systems because of the method it uses to filter dangerous compounds.
2. Water purifying Standard support is necessary
   Another drawback of filtration is that homemade water purification systems typically aren't very effective in producing safe drinking water. To properly sift through all of the dangerous living things and metals, these structures need to undergo routine maintenance and be routinely replaced. More harm will be done if these treatments are not followed than if you just drink water straight from the faucet. The dolphin from the ocean leaps in at this point. Ocean dolphins advise water purification as a method. Nevertheless, it needs to be done with the utmost care. To supply safe drinking water, water and channels must be consistently, expertly, and sufficiently maintained. Microorganisms and hazardous metals, which might result in dangerous illnesses, must not be present in water. The water must be safe and beneficial to life [35].

The Purpose and Advantages of Monitoring Water Quality

1. Water quality monitoring facilitates the identification of individual pollutants, a specific chemical, and the source of the pollution. Industrial activity, dumping in rivers and on the ocean floor, the use of pesticides and fertilizers in agriculture, oil pollution, port activity, shipping, and oil spills are only a few of the many factors that contribute to water pollution. Sewage discharge and agricultural operations are further sources. Regular evaluations and monitoring of water quality provide data that can be used to identify existing issues and their root causes.
2. Spotting both transient and long-term trends in water quality. Data collected over time can show trends, like increasing nitrogen pollution levels in a river or other inland waterways. Then, using the entire data set, significant water quality parameters will be discovered.
3. As part of environmental planning, controlling and preventing water contamination. To create a strong and successful water quality strategy, data must be gathered, interpreted, and used. However, a lack of real-time data will make it challenging to establish strategies and will restrict your ability to have an impact on pollution control. Utilizing digital tools and systems for data collection and management is the solution to this issue.
4. Compliance with international standards.
   Monitoring water quality has an international impact on both land and sea. The European Green Deal publishes various laws to set standards for water quality and lays out objectives for restoring biological diversity and lowering water pollution inside the European Union (EU). Additionally, every nation state, including France, has a legal structure unique to that country that requires precise water quality monitoring. State-by-state water contamination regulations in the US are enforced by the Environmental Protection Agency (EPA). Nations all around the world are beginning to understand how important it is to use efficient methods and measures to check the quality of the water.
5. Monitoring water quality during emergencies is essential. Examples include well-known incidents of oil spills brought on by tanker accidents or cases of flooding brought on by excessive precipitation runoff. Quick action is necessary in an emergency; therefore access to real-time data is required to ascertain how pollution levels affect water quality [27], [34].

CONCLUSION

The study's objectives were to develop, evaluate the performance of, and evaluate the implementation of an IoT and LoRa based device for monitoring water quality using the Node-RED program for component architecture and design. Depending on the site that needs to be evaluated, it requires measuring and gathering data on water quality features like temperatures, electrical conductivity, pH level, the state of the air, and sediment. Before transmitting the sensor data over the wireless network to the database, where the Node-RED dashboard shows it, the TTGO LoRa32 microcontroller processes it. The results of the investigation demonstrated how a signal transmission that successfully transferred more than 95.50% of our 600 data sets over this shorter distance could be utilized to send and receive data across a distance operation of 2.0 km in locations where LoRa technology is not feasible. Less storage will therefore be required for longer trips. The IoT-based monitoring system can also provide a Node-RED dashboard and real-time measurements of water quality. Usability testing was shown to be more practical and efficient in terms of time. Modern tactics like the smart city are compatible with this approach. A real-time monitoring system will therefore be increasingly in demand. The system's BOD/COD sensor integration and the creation of a new LoRa antenna to improve signal transmission will be the focus of future work. The obstacles and effects of water monitoring are explored in this study's review of several articles.

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