

A Review on Internet of Things (IoT) Based Water Monitoring System

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ABSTRACT

Current advancements in sensor networks are crucial for environmental remediation. The Internet of Things (IoT) connects numerous devices that may share and collect data. IoT expands its capabilities to include environmental concerns in addition to the automation sector by utilizing industry 4.0. Polluted water has emerged as one of the most serious dangers in latest days since drinking water has been contaminated and polluted. Contaminated water may trigger a variety of illnesses in humans and animals, affecting the ecosystem's life cycle. This means, there is an increased demand for water which might affect the available sources of water at large. Therefore, effective management and monitoring of available resources of water is the need of the hour. This review paper includes the use of Internet of Things (IoT) technology for physical parameters of the water monitoring systems to manage and save scarce water resources. The traditional method to monitor water quality and quantity has been a quite difficult task involving a large amount of labour and cash. But the IoT application slashes human involvement and most of the procedural decisions are made by algorithms. Thus, smart methods for investigating water contamination are becoming increasingly significant with advancements in sensors, communication, and IoT technologies. A water monitoring system (WMS) is a low-cost and feasible system that uses IoT technology to analyse the quality of drinking water: use of IoT tools for water monitoring will be a step in the right direction. Even though there are many great technological advancements for the surveillance of water quality, the research field is still challenging. This article aims to unveil the recent research for developing intelligent, energy-efficient, and highly effective water monitoring systems that will allow for continuous monitoring of water in less privileged areas of Pakistan. This article will assist researchers and administrative organizations in starting pertinent investigations of water in rural areas by utilizing a WMS.

Keywords: Internet of Things (IoT), Water Monitoring, Sensors Used for Water Monitoring

INTRODUCTION

The parameters which should be considered for water quality monitoring are already defined by World Health Organization (WHO). However, the contaminating factors which degrade water quality are the progress of industrialization (Abubaker et al. 2018) and much reliance on the agriculture sector. Moreover, the uneven distribution of rainfall, floods, droughts, and lack of education and awareness about proper usage of water contribute to water contamination thus, worsening the situation. The World Water Assessment Program estimates that every day about

two million tons of human waste is disposed of into the water. Coping with this issue is of prime importance.

Nowadays, it has become important to spread awareness about the implementation of the water monitoring system. Traditionally, the techniques involved bringing results together, for instance, the existence of small metals, oils, pesticides, mixed oxygen, nutrients, and samples of chemicals. The physical conditions such as temperature, the flow of water, and erosion are also counted, and they give useful insight as well as biological facts (Nikkam et al. 2016). The common techniques to measure these parameters are condition monitoring which is used to identify environmental conditions and trends by

examining the condition of the water body, and another is Problem investigation monitoring which includes examining problems or threats to identify specific causes of impairment and quantify inputs of pollution (Bhatt et

al. 2016). Another technique that is used for water quality monitoring is the help of the IoT method which is the focus of this paper as well. Figure 1 shows an overview of IoT based water management system.

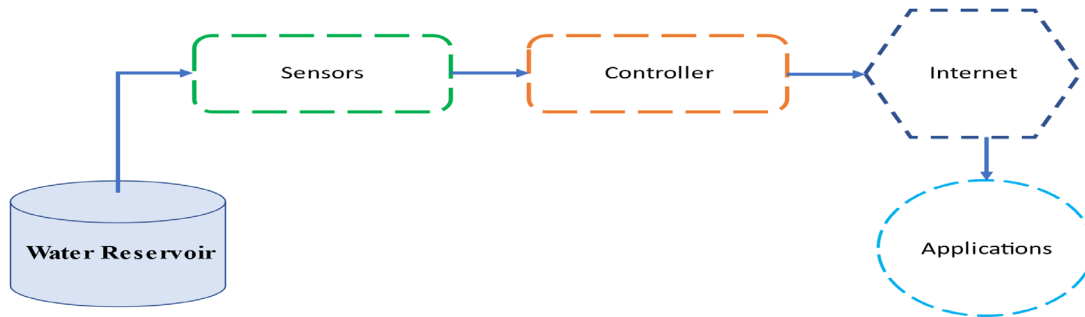


FIGURE 1. Overview of a Water Management System

The IoT system depends on a controller, sensors, and an application to demonstrate the data. Sensors are devices that are connected to the controller to record pH value, turbidity, and many other values. Once these values are collected then the sensors transmit them to the controller. The controller is small size computer that can connect to

the network and execute the programs. The controller can be programmed in such a manner that it can get values from the sensor and send those values to the internet for storage and analysis. In Table 1 critical analysis is made of the techniques used for the water monitoring system through the Internet of Things

TABLE 1. Critical Analysis of IoT Based Technology

Technique	Problem-focused	Limitations	References
Various sensors used with Advance RISC Machine (ARM) based multipoint control unit (MCU) controller	water pollution due to human waste, industrialization, and disaster is being assessed	use of an optical sensor to monitor the turbidity is not a reliable approach	(Nikkam et al. 2016)
System designed in Neural Network model; system operated by the use of Remote sensing technology	Water impurities assessed in the aspects of pH, oxidation and reduction potential (ORP), and conductivity	No interface system used	(Prasad et al. 2015)
All the sensed data from sensors is passed to the raspberry pi using the zig bee protocol	Impurities being identified with the use of low power consumption and low bandwidth	data that is being measured has no proper representation	(Bhatt et al. 2016)
A WI-FI module, ESP8266 is being used which connects the microcontroller to the internet and all the Sensed data is being delivered to a web server	apart from the temperature of the water, the level of carbon dioxide dissolved in water is also being assessed.	material that is being used is of high-power consumption	(Spandana et al. 2018)

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The Arm7 is connected to the data concentrator which is present in India's TWARD department and data is sent to the TWARD dept. via ZigBee module and their water parameters are monitored	to avoid the need of testing water quality manually	when it comes to maintenance the design aspects are complicated	(Chavan et al. 2016)
The gathered sensed data from sensors is sent to the servers by Message Queuing Telemetry Transport. (MQTT) algorithm. This algorithm makes communication much more reliable	It is still a complex area to monitor water quality, so naive Bayes theorem is used to carry out an analysis.	There lie some accessibility and security concerns regarding device authentication	(Abubaker et al. 2018)

INTERNET OF THINGS SYSTEM (IOT)

The IoT is comprised of mainly three prime phases which include sensing hardware, transmitting data over a network, and processing data (Encinas et al. 2017). The IoT is more advance in its approach than the internet and short-range communication networks to obtain identification intelligently, track a location, exchange information, and monitor network management such as Global positioning system (GPS), Radio Frequency Identification Devices (RFID), Laser scanner and infrared sensor (Lambrou et al. 2014).

The IoT is an innovative concept that can build an intelligent and smart system of interrelated computing devices, digital and mechanical machines, and other objects regulated by unique identifiers (UIDs) and have the ability to transmit data over a network without the need for a human-to-computer or human-to-human interaction (Hlaing., 2017; Alshattnawi et al. 2017; Malche et al. 2017; Yun M et al. 2010). The IoT system has the potential to decrease human dependency and simultaneously can increase productivity (Mudumbe et al. 2017). The system is being used almost all around the world in various project development thus, helping in monitoring processes ranging from healthcare, surveillance, and environment (Upadhyay et al. 2019).

There are many applications of IoT used for the real-time water monitoring system. Geetha (2017) used the IoT for real water monitoring in India. Mahbubur (2020) used IoT to monitor the DO, salinity, turbidity, pH, and temperature in Bangladesh. Uferah (2018) used IoT to monitor the surface water in Pakistan.

Figure 02 shows the relationship between IoT and other networks. The important characteristics of IoT include using RFID sensors and dimension codes to gather data on objects. Also, the consistent transmission which is sending the real-time data of objects over a variation of

telecommunication networks and the internet and intelligent processing by using intelligent computing such as cloud computing and unclear identification to analyse and develop a huge total of data and information to carry out intelligent control to objects (Yun et al. 2010). As far as storage and calculation in IoT systems are concerned, cloud computing is a good choice as it is a big-scale low-cost processing unit consisting of Internet Protocol (IP) for communication of connection. The water monitoring system contains a wide distribution of network and monitoring sensors but with the utilization of cloud storage, there are fewer chances of the occurrence of any problem in storing data.

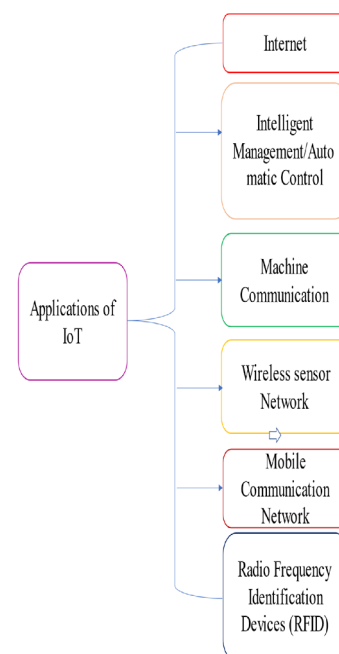


FIGURE 2. Relationship of the present network with IoT (Abubaker et al. 2018)

SENSOR AND TYPES OF SENSORS

There are different sensors available in the market for measuring various parameters such as humidity, range, and temperature in IoT-based systems. The generally used sensors in water monitoring systems based on IoT are temperature sensors, pH sensors, and ultrasonic sensors.

PH SENSOR

Power of Hydrogen or pH sensors are used to check the alkalinity or acidity level of water. A pH value below 7 indicates the acidic nature of water whereas a value above 7 shows the basic nature of water. A pH value equal to 7 shows neutrality and an optimal pH value recommended by WHO (WHO., 1996) is in the range of 6.5-9.5.

TEMPERATURE SENSOR

According to WHO guidelines (WHO., 2018), Water temperature is an important element of control strategies against Legionella. Wherever possible, water temperatures should be kept outside the range of 25–50 °C and preferably outside the range of 20–50 °C to prevent the growth of the organism". Hence, the temperature is an essential factor to check the quality of water, and multiple sensors are available to measure temperature in different ranges for example from -50 °C to 125°C.

ULTRASONIC SENSOR

Ultrasonic sensors measure the water level in a tank or reservoir. An ultrasonic sensor is also a distance measurement sensor that can easily relate to various controllers. To measure the water level in a tank or reservoir with real-time, ultrasonic sensors are widely used.

WATER QUALITY PARAMETERS

It is an arduous task to measure drinking water quality because it involves the measurement of various parameters. Some parameters can be measured easily whereas others require expertise and special hardware. The following are the generally used parameters to monitor water quality.

PH

pH is the measure of the acidic and basic nature of water. Its total values of pH are 14 which shows the basic solution.

On the other hand, lower values of pH depict acidic nature. WHO recommends an optimal pH value in the range of 6.5 to 9.5. The pH electrode is usually glass and fragile. The pH sensor or pH probe is connected to the pH sensor module and a single conditioning board which gives an output of pH values. The analog sensor (pH sensor) sends data to Arduino. pH meter voltages range from 0 to 5, where 0 indicates highly acidic and 5 indicates a highly basic solution. So, 2.8 is multiplied by voltages and gets the expected pH value.

TOTAL DISSOLVE SOLIDS

TDS is the measurement of total dissolved inorganic and organic material in water. If the presence of minerals is greater than the TDS value is high. The suggested value of TDS for potable water is 500 mg/L. Whereas, it is unsuitable to drink water having a TDS value greater than 1000mg/L.

DISSOLVE OXYGEN (DO)

The amount of oxygen dissolved in water can be utilized to gauge water quality. The oxygen dissolves in the water in different ways such as through water aeration, and ambient air diffusion. The quantity of dissolved oxygen in streams and rivers is higher than the amount in stagnant water. The highest quantity of DO causes rusting in pipes but makes the water taste better. The DO sensor is connected to Arduino. It applies to many fields such as aquaculture, agriculture, environmental monitoring, and so on. The DO is one of the essential parameters for water quality. A low level of DO causes breathing problems which can endanger the lives of aquatic life.

CONDUCTIVITY

The potentiality of water to conduct electricity is known as conductivity. The conductivity indicates what is dissolved in the water. For drinking water, the conductivity values should not be greater than 400 μ S/cm.

TURBIDITY

Turbidity is the measurement of water clarity. In other words, it is the prime test to judge the quality of water. It is generally measured in the Nephelometric Turbidity Unit or Formazin Turbidity Unit (FTU). The WHO guideline states that the turbidity level for drinking water should not be greater than 5 NTU.

SALINITY

Salinity defines the amount of salt dissolved in water. Higher salinity impacts largely human health. The recommended value for salinity in drinking water is less than 200 ppm.

TEMPERATURE

Temperature impacts significantly the quality of water. According to WHO the temperature limit for drinking water is 30°C. A comprehensive study on the effect of temperature on the water is presented in (E. Vallino, L. Ridolfi, F. Laio., 2020) [20].

CONCLUSION

The IoT based water monitoring system play an important role in the Effective water management system especially for smart cities and higher institutions and their ambiances has become crucially important these days. To meet the challenge, the use of IoT devices is becoming rapidly popular because of their economical appliances. In their paper, a water monitoring system using IoT was described along with all other prevailing water monitoring systems. Different parameters of water, water level, and pH level were identified, and evaluation of all other water measurement systems based on these input variables was performed. The confrontation like power saving for real-time measurement was still there. Therefore, IoT and machine learning-based systems for smart water management is also suggested as a future remedy for all the issue. This also operates machine learning-based possibilities which can enhance the efficiency of the smart management system. Besides this, the aspect of covering IoT for the assessment of unpredictable calculations can also be included in the upcoming endeavors. In the same way, the authenticity of prediction for water management systems for agricultural purposes and flood control is also a confrontation. Quantifying water economic scarcity (WES), especially in the field of irrigation using IoT devices can further be researched.

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DECLARATION OF COMPETING INTEREST

None

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