Digital Water Quality and Quantity Management System

Dr.M.V.Bramhe

Professor, Department of Information Technology, St. Vincent Pallotti College of Engineering and Technology, Nagpur (India)

Abstract

In recent years, water pollution has become a major issue, posing a risk to the deterioration and contamination of supplies of drinking water. In addition to harming people and animals, pollution also upsets the delicate ecosystems' balance. However, by spotting water contamination early on, we can take the necessary action and avert serious problems. Real-time monitoring of water quality is now essential to ensuring a consistent supply of clean water.A comprehensive solution for efficiently and sustainably monitoring, analysing, and optimising water resources is the digital water quality and quantity management system. Modern technology that can efficiently manage both water quality and quantity are urgently needed given the rising global demand for freshwater and the growing concern over water pollution.This system makes use of a network of sensors and data gathering tools to continually monitor different water quality-related factors like pH levels, dissolved oxygen, temperature, turbidity, and the presence of pollutants. Real-time transmission of the gathered data to a central control facility allows for processing and analysis utilising sophisticated algorithms and machine learning methods.The suggested system makes use of IoT technology to build an interconnected network of sensors and devices. These gadgets gather real-time information on variables affecting water quality, including pH levels, dissolved oxygen concentrations, turbidity, and chemical pollutants. This data is transferred to a centralised system for analysis and monitoring using cutting-edge communication protocols.

Keywords: IoT, Controller, pH, Sensors, Water quality, cloud Server

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I. Introduction

A cutting-edge technology answer to the problems with water management is the Digital Water Safety and Quantity Management System. [20] This system makes use of data analytics, digital technology, and sophisticated monitoring methods to ensure effective management of water resources in terms of both quantity and quality. This system gives water resource managers and stakeholders real-time monitoring, analysis, and decision-making help by combining multiple components such sensors, data platforms, and analytics tools.For environmental preservation, public health, and sustainable development, water

quality and quantity are essential. Traditional water management strategies frequently rely on time-consuming, expensive, and scope-limited manual sampling and testing. This procedure is revolutionised by the Digital Water Quality and Quantity Management System, which makes continuous monitoring, data collecting, and real-time analysis possible [21].

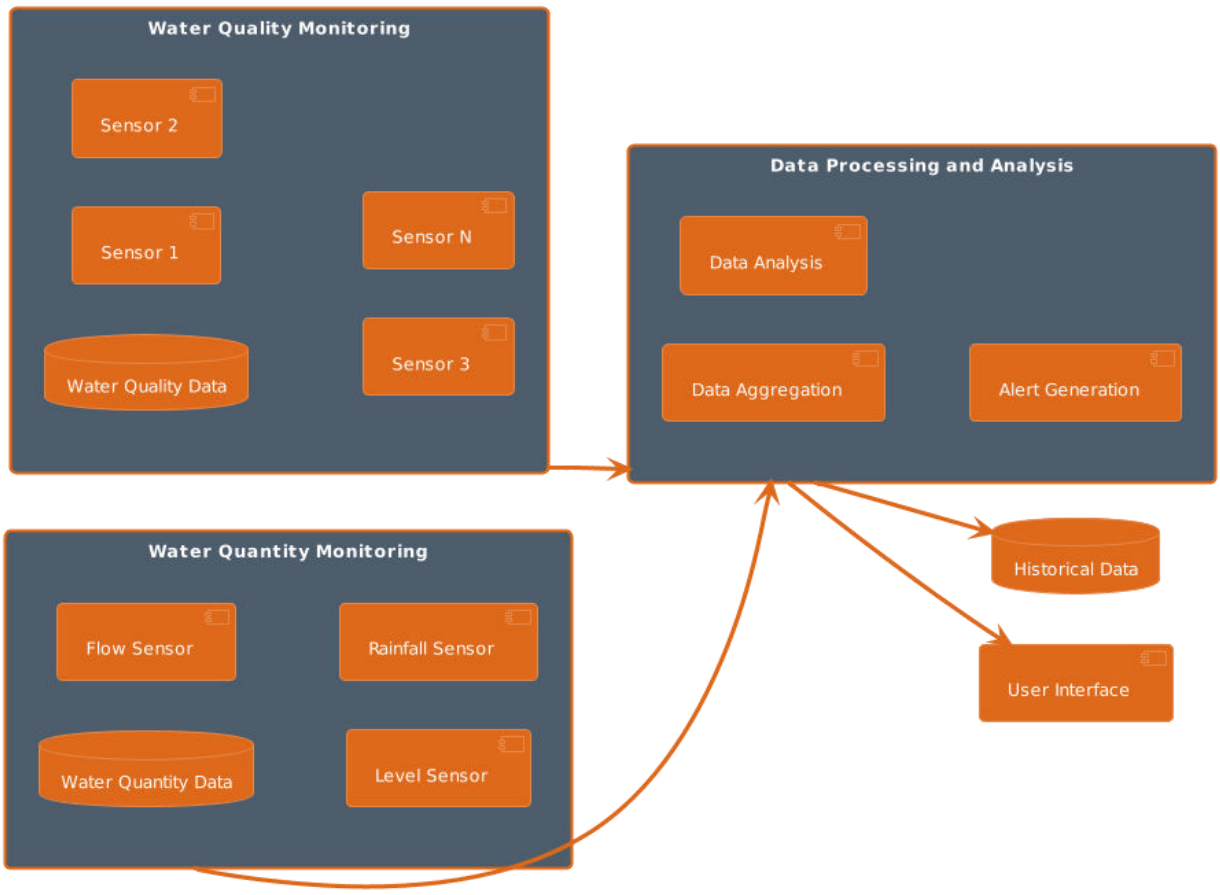


Figure.1 Components of water quality monitoring system

The Digital Water [8] Safety and Quantity Control System, which is IoT-based, is made to handle problems with real-time billing, automatic valve management, and tracking water usage. This system makes use of Internet of Things (IoT) technologies to track water flow for each individual user, manage valves, and monitor water usage. It provides precise billing based on actual use as opposed to a conventional fixed rate tax by analysing real-time data on water usage.The manual water distribution system now in use by municipal corporations makes it challenging to track consumer-level water use. By offering a digital remedy that measures both the quality and amount of water consumed, this device gets beyond that restriction. This guarantees optimal water distribution and enables efficient management [9] [10].

The system's [12]capacity to simplify billing procedures is one of its key benefits. The system creates invoices based on real consumption by precisely tracking water usage for each user. Due to the elimination of estimation and fixed rates, billing will be fair and there will be less disagreements. By delivering real-time information on delinquent bills, the system also aids in boosting revenue collection. This makes quick action possible and lowers the price of bill recovery operations.

Additionally, [13] [14] the technology allows for automatic valve control, making it possible to manage water flow effectively. It can identify leaks, unusual consumption patterns, or unlicensed water use and initiate the proper responses, such as turning off the water supply or notifying the relevant authorities.The system offers continuous surveillance, analysis of data, and remote management capabilities by utilising IoT technologies. As a result, water management organisations may get a clear picture of the water distribution system, keep track of demand trends, and make defensible choices about resource optimisation and infrastructure planning.

II. Review of Literature

The author suggests the installation of an integrated water distribution system to solve the issues of water wasting due to unintentional pipe leaks and the lack of a record-keeping system for water distribution and repairs. This technology seeks to give users online pre-intimation and pre-scheduling of water distribution. Users can also receive information regarding the state of their water supply via an SMS or mobile app [1].

To address the lack of a system for monitoring the quality of drinking water, the author also recommends the creation of a water quality monitoring system based on IoT. The real-time monitoring of water quality indicators is accomplished by this suggested system using wireless sensor networks and Zigbee modules [2].

Multiple [17] advantages are provided by the integrated water distribution system. First, because customers are aware of water distribution schedules in advance, preventative actions can be implemented in the event of unintentional pipe leaks. This can lessen water waste and the harm brought on by leaks.

A monitoring system that uses sensors to measure different water quality characteristics, such as turbidity, pH value, water level in the tank, wetness of the surrounding environment, and water temperature, was proposed by Pasika and Gandla [3]. These sensors are linked to a microcontroller unit (MCU), and a personal computer (PC) is used to process the data further. For real-time water quality monitoring, the gathered data is subsequently transmitted to the cloud via the Internet of Things (IoT)-based ThinkSpeak application.

An IoT-based Intelligent Water Quality Monitoring (SWQM) system was created by Mukta et al. [4] and allows for continuous measurement of water quality based on pH, temperature, turbidity, and conductivity of electricity. Four sensors, each coupled to an Arduino Uno, are used by the system to perceive and continuously monitor these quality characteristics.

A approach for creating a reconfigurable sensor interface device for a Smart Water Quality Monitoring (SWQM) system in an IoT setting was put forth by Konde and Deosarkar [5]. A Field Programmable Gate Array (FPGA) board, sensors, and a Zigbee-based wireless communication module were some of the components used in the system.The SWQM system was designed to continuously track six key indicators of water quality. These variables included the amount of turbidity (cloudiness of the water), pH level, humidity, water level, water temperature, and the quantity of carbon dioxide (CO2) on the water's surface [18].

A wireless sensor network-based Solar Powered Water Quality Monitoring system was suggested by Amruta and Satish [6]. In order to monitor water quality utilising wireless sensor network (WSN) technology, the system uses an Underwater Wireless Sensor Network (UWSN). Solar or photovoltaic panels are used to power the UWSN, which uses solar energy to run.

In order to monitor the water quality in various water resources, Jerom B. et al. [7] suggested a Smart Water Quality Monitoring System based on the Internet of Things (IoT), including cloud computing and deep learning algorithms.The system uses Internet of Things (IoT) technology to collect information from numerous sensors placed in diverse water resources. These sensors measure and gather information on several factors, including pH values, turbidity, dissolved oxygen, temperature, and other important water quality indicators.

III. Methodology

A typical water quality monitoring system includes a number of sensors, including pH, turbidity, temperature, conductivity, humidity, and others. The system uses these sensors to measure a variety of variables relating to water quality. The core controller is in charge of coordinating the entire process and is the primary component in the block diagram of the system (as shown in Figure 1). The sensors are connected to the core controller, which acts as the data collection interface. The central controller receives data from the sensors and processes, analyses, and compares it to predetermined benchmark values, among other responsibilities. This enables the assessment of water quality using recognised standards [25].

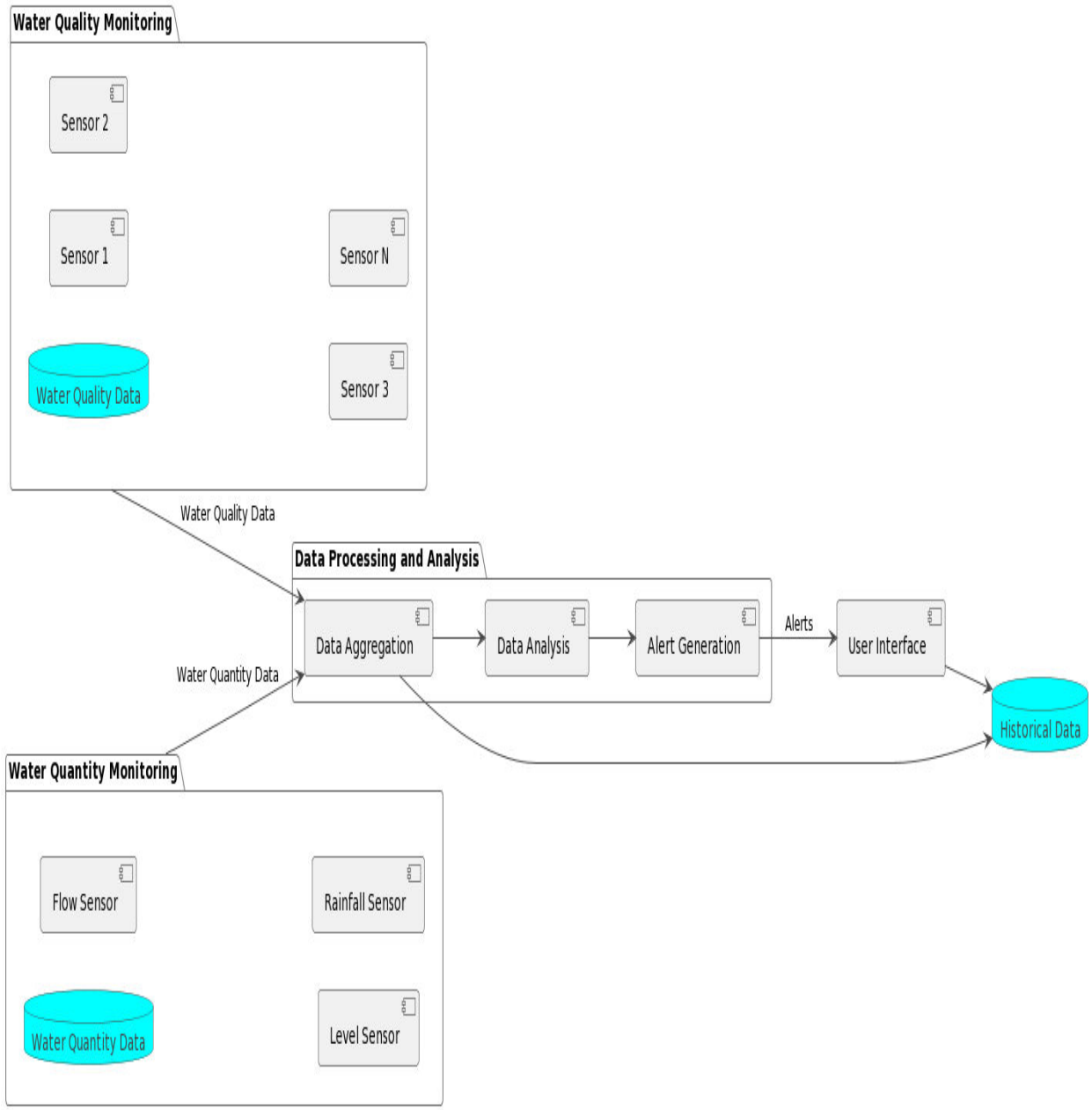


Figure 2: Proposed Schematic diagram of water quality monitoring system

To allow communication between the main control and the intended users of the water quality data, the system includes wireless modules. This can include end users, such as those who keep an eye on the water quality in their houses, or organisations in charge of managing water resources more broadly. The wireless modules make it possible to quickly and efficiently transmit the measured data to the appropriate recipients.

Table 1: Details of Quality parameter for water

pH Value	Turbidity (NTU)	Conductivity (µS/cm)	Carbon Dioxide (mg/L)	Humidity (%)	Temperature (°C)

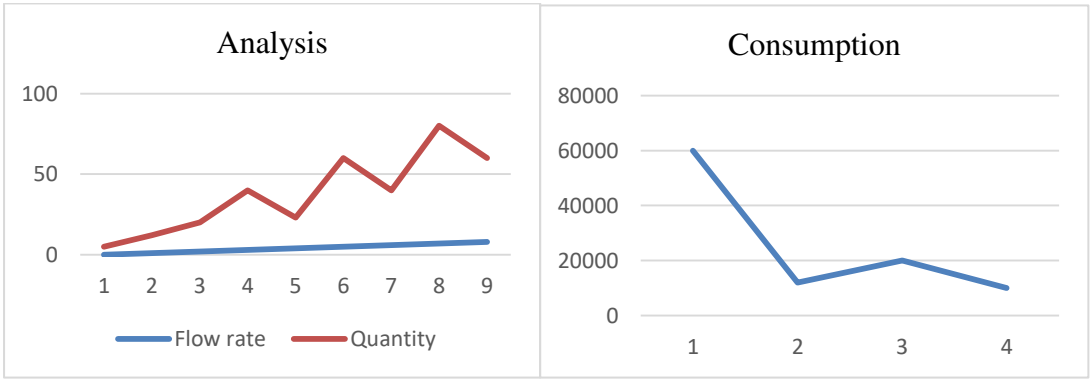
7.3	4.1	460	1.10	41	21
9.4	5.7	620	1.720	61.44	27.4
9.82	5.43	719	1.79	65.67	23.4

Numerous sensors, including pH, conductivity, temperature, turbidity, and others, are connected to the central controller in a water quality monitoring system. These sensors are inserted with their leads submerged in the water sample that will be examined.The analogue signals from the sensors are subsequently processed by an Analog-to-Digital Converter (ADC) to turn them into digital data. These digital values are read by the core controller and uploaded to the cloud for additional analysis and monitoring.

By comparing the sensor readings with predetermined threshold values, continuous monitoring is accomplished. The core controller continuously monitors the sensor data to see if they rise or fall above predetermined thresholds, potentially suggesting problems with the quality of the water.

IV. Result Analysis

Our solution gets beyond the drawbacks of conventional metres, which rely on analogue and non-electric physical flow sensors that might give false readings, especially when there is low water pressure. Our method, in contrast, offers precise calculations of water usage statistics throughout time.The current system efficiently tracks water use and the flow of water. Customers make a predetermined payment, and the system notifies the metre of the allowable unit data. The meter's flash memory contains these details. The technology reduces the permitted unit details in the flash memory as water is consumed. The technology alerts the server and shuts off the water supply automatically when the reading falls to zero.



(a) **(b)**

Figure 3: Quality and Quantity of water along with flow

Hardware, a web server, and a website application make up the three primary parts of our system. The hardware module has parts that regulate the water flow, including a flow sensor, a solenoid valve, and a microcontroller. The web server module is made up of the server parts, such as the database, web application, and web server that retrieves and stores the

metre readings. The online application acts as an interface, offering users a website or mobile app to track their water usage. Proposed system, result shown in figure 2, integration of these modules assures precise water consumption monitoring, simplifies billing administration, and gives users the ability to effortlessly watch their water usage via the internet or mobile application.

The solenoid valve in the digital water quantity and quality management system regulates the flow of water for further processing. Water flows through the sensor when the valve is turned on, but when it is turned off, the flow is stopped. Utilising a flow sensor, the amount of water going through the system is calculated and measured in litres per second. The device provides real-time information about the water flow by displaying the readings and values on an LCD screen. In addition, the technology takes and stores all data in a server application or database. Users may view their water metre readings via an Android app, which makes it simple to access the data.

The device gives consumers control over the flow of water in their houses, allowing them to regulate and change their water usage as needed. This feature raises customer awareness and encourages effective water management. Billing is properly calculated using water flow data, guaranteeing that consumers are charged for their actual consumption. Technology provides transparency and visibility into water-related costs by allowing consumers to readily access and examine their invoices. A comprehensive solution for monitoring and managing water flow and consumption is provided by the digital water quality and quantity management system. It is made up of several parts, including an Android app, an LCD screen, a server programme or database, and a solenoid valve. The system optimises water management efficiency and encourages conservation by merging these components.

V. Conclusion

A significant step forward in water management and conservation is the digital management system for water quantity and quality. It provides a dependable and effective substitute for conventional water distribution techniques and a means of managing and keeping an eye on water resources. This system ensures continuous monitoring and evaluation of both the quantity and quality of water by utilising IoT technologies. The system uses a variety of sensors, including pH sensors, turbidity sensors, temperature sensors, conductivity sensors, and more, to precisely monitor and track water parameters.The use of the digital water quantity and quality management system ensures that water quality standards are followed as well as permits quick identification of any discrepancies or deviations. The system also includes sophisticated invoicing and metering tools that guarantee that customers are appropriately invoiced based on their actual freshwater usage. The system delivers exact water distribution and reduces waste by using automated valve management and flow tracking. Customers can quickly access their water consumption statistics thanks to the availability of smartphone applications or web interfaces, enabling them to efficiently monitor and manage their usage. The technology provides water management authorities with sophisticated predictive analytics by utilising cloud storage and deep learning algorithms.

Making educated decisions is made possible by providing decision-makers with useful insights for resource distribution, infrastructure development, and water allocation.

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