# IOT Based Real Time River Water Quality Monitoring and Control System

*Dinesh* P.M[1*], *Shree Sapnaa* K[2], *Kiranisha* A.J[3], *Sabeenian* R.S[1], *Paramasivam* M.E[1], *Manjunathan* A[4]

[1]Department of Electronics and Communication Engineering, Sona College of Technology, Salem, India
[2]Programmer Analyst, Capgemini, India
[3]Software Engineer, Cognizant, Banglore, India
[4]Department of Electronics and Communication Engineering, K.Ramakrishnan College of Technology, Trichy - 621112, Tamil Nadu, India

**Abstract**: Water quality monitoring systems currently in use are manual and involve tedious processes that are time intensive. This research suggests a system with sensors for water quality monitoring. Access to real-time data may be obtained through remote monitoring and the Internet of Things. A wireless sensor network (WSN) contains a micro-controller for data processing, a mechanism for communicating between and inside nodes and many (IoT). Using Spark flow analysis with Spark MLlib, deep on it. The agent will receive a warning SMS automatically if the detected value exceeds the threshold. Our plan to develop a high- frequency, high-mobility, low-power water monitoring system makes it special. As a result, the Bangladeshi people will find our proposed approach highly useful in raising awareness of and putting an end to water pollution.

## 1 Introduction

The environment makes up five crucial elements. B. Soil, water, climate, natural vegetation, and terrain Water is the most essential of these for human life.For the survival of other ecosystems as well, it is tectonic. Water that is safe and easily accessible must be used for all purposes, including drinking, household, food production, and enjoyment. Therefore, keeping the water quality in balance is very important. If not, it will negatively impact both human health and ecological harmony among different species. The most significant worldwide issue is water contamination, which calls for ongoing evaluation and coordination of international water resource governance principles down to individual wells. According to studies, water pollution is the world's top killer and disease-causing factor. Records indicate that water contamination causes the deaths of more than 14,000 people every day worldwide. Without the correct pretreatment, contaminated or polluted

[*] Corresponding author: pmdineshece@live.com

water is utilized for drinking in many poor nations. One reason for this is public and administrative unawareness and the lack of water quality monitoring systems that lead to serious health problems. The architecture of a wireless sensor network (WSN) that facilitates water quality monitoring utilizing data gathered from submerged sensors is presented in this paper. This system may record many water properties such as pH, liquid oxygen, turbidity, conductivity, temperature, etc. with the use of numerous sensors. New methods for real-time data capture, transmission, and processing are available thanks to the WSN technology's quick development. Customers can remotely receive continuous information about water quality. Today, the Internet of Things (IoT) is revolutionary technical occurrence. It shapes the world today and is utilized in many areas to collect, monitor and analyze data from remote location. From smart cities, smart power grids, smart supply chains to smart wearables, IoT integrated networks everywhere. IoT is still underutilized in the environmental space, but it has great potential. Applications include detecting forest fires and early earthquakes, reducing atmospheric population, monitoring snow depth, and preventing landslides avalanches. Additionally, it can be implemented in the field of water quality monitoring and control. In the twenty-first century, researchers are becoming more interested in water quality monitoring. On this topic, a lot of work has been done or is being done, concentrating on different elements of it. The creation of an effective, affordable, technology for monitoring water quality in real-time utilizing electronic sensor networks and the Internet of Things was the overarching topic of all initiatives. An IoT-based sensor network is used in this study to track the physical and chemical characteristics of water bodies in Chittagong City.

Figure 1 represents the full scheme of the system. This graphic shows the architecture of the complete system. The whole system's architecture is depicted in this diagram. Each reservoir in the suggested design is linked to a sensor node by a string of sensor probes that may gauge variables like pH, turbidity, etc. The signal conditioning circuit is designed to provide output of the sensor to the processor board via an analog-to-digital converter in compliance with the sensor probe and sensor processor board specifications. Data is processed by a processor board in accordance with quality requirements before being sent through a transceiver to a central server. The data collected at each reservoir is sent to the central server either directly or indirectly via the transceivers of other sensors or repeater nodes.

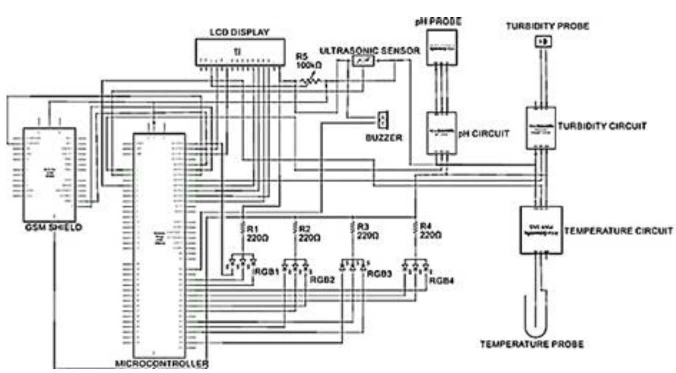


**Fig. 1**. Detailed diagram of water quality monitoring system.

## 2 Literature survey

J. Navarajan et al [1] This research Water management and the detection of water pollution IoT smart sensor for clean water supply to do this, real-time quality monitoring is required.

It was suggested to use an innovative IOT-based water quality surveillance method. This system includes sensors that detect many aspects of water quality, including temperature, conductivity, dissolved oxygen, turbidity, pH, and more. The Raspberry Pi Zigbee protocol is used to remotely connect to the core controller once the microcontroller has processed the sensor readings. Water monitoring system and scenario based on current water quality investigations. The suggested approach is better suited for real-time monitoring of water quality indicators. Natasha Markovich et al. [2] This study uses a sensor web to monitor and warn about river water pollution. System Sensor Web offers the foundation for collection. processing information from diverse and distributed sources sensor. Numerous discoveries were made thanks to this set of technologies. implementation, particularly in the sphere of monitoring the environment. Crisis sensor web architecture This white paper's management model is an active keeping an eye on the measurement parameters and responding quickly disasters in the environment as examples. stream water On top of this architecture, a management and alerting system is constructed. facilitating river water and environmental management and access. K. A. UnnikrishnaMenon et al. [3] This research studies on the quality of river water monitoring of a wireless sensor network in India This essay focuses on the purity of river water. using a wireless sensor network as a monitoring system useful for the remote and ongoing monitoring of water quality information. The system's wireless sensor nodes are used to measure the pH of water, one of the primary factors influencing water quality.

Prasad et al. [4] created a method employing remote sensing and his IoT technologies for a smart water quality monitoring system in Fiji. Hydrogen potential (HP) and oxidation-reduction potential (ORP) are the quality indicators used in water analysis (pH). An early warning system for water pollution will be designed and fully implemented with a large number of measurement stations through the efficient execution of this monitoring technique. Additionally, research on the Fijian Islands' water quality will be presented. For IoT and remote sensing water quality monitoring, a frequent data gathering network is necessary. Studies that compare numerous parameters, including turbidity, pH, temperature, and conductivity, are provided. The developed system has shown to be effective by providing accurate and reliable information for real-time water monitoring. Leonid Stoimeno et al [5] This academic paper Using a sensor network to monitor and warn about river water pollution System The collection infrastructure is provided via the sensor web. processing information from diverse and distributed sources sensor. Numerous discoveries were made thanks to this set of technologies. implementation, particularly in the sphere of monitoring the environment. Crisis sensor web architecture This white paper's management model is an active keeping an eye on the measurement parameters and responding quickly disasters in the environment as examples. stream water Building a management and warning system on top of this architecture to enable river water management and access environmental damage. Maneesha V. Rameshet al,[6] This study focuses on the usage of a wireless sensor network to monitor river water quality in India. This research offers a wireless sensor network-based river water quality monitoring system that aids in remote and ongoing monitoring of India's water quality data. The system's wireless sensor node is intended to track the pH of water, one of the primary factors influencing the water's quality. a network of wireless sensors that supports river water quality monitoring. This research also suggests a novel method for creating a water quality sensor node that can be used to track water's ph.

# 3 Hardware architecture

## 3.1 Command Surface

It features an Arduino Mega as its focal point. The Mega 2560 was the martyred Arduino in this case. This is so that it ca. work with the Arduino system, which require several analogue character sensors. It has a collection of registers that serve as RAM for one use alone. Certain intentional recognition registers of on-chip component resources are also mapped to aggregate graphemes. Memory addressability varies between instrument series and all his PIC devices with multiple bank mechanism using addressing to additional capacity. Motion instructions on later device series require hidden movements to execute through registers. So with the help of encoding, this mechanism works intrinsically with the Arduino UNO R3 Skate.

## 3.2 ph Detector

Be gradually declining pH levels can mean a lot to an author, the pH of an item is an easy constant to show. A pH sensor monitors the hydrogen ion density in bleach and determines whether it is acidic or alkaline. There are pH ranges of 0 to 14 in its makeup. The solubility of elements and compounds is also processed by extreme pH, cyaniding them. In math, pH is defined as pH = -log [H+].

## 3.3 Turbidity Detector

To test the purity of particles or sludge in water, turbidity column sensors are employed. Typically, cut feed pulp has an NTU of 255. At 80 NTU and higher, irrigation is present. 130 to 250 NTU is the normal range for drinks that are not fortified. Two components make up the turbidity instrument: a soft transmitter and an acquirer. Turbidity results in less clear water, less aesthetically pleasing, slower photosynthetic rates, and higher water temperatures.

## 3.4 Temperature Detector

The DS18B20 here is old for a thermometer. Generally, it is used to measure the current living temperature, but if you mistakenly attach it to a conductor electrode and put it in water, it will also be able to detect the temperature of the water. Normal human body temperature is (25 -30)°C.

## 3.5 LCD Projector

LCD (liquid crystal display) displays are flat-bracket electronic displays with widespread use nationwide. The 16x2 LCD demo has very basic performance, which is frequently hampered by other components and circuits. Heptad segments and multisegmented LEDs are not as effective as these modules.

## 3.6 Wireless Component

Wireless localization area plans with equipment are discussed in relation to Wi-Fi. Computers, gaming systems, mobile devices, digital cameras, paper computers, and other equipment are among the gadgets that support Wi-Fi.They also include contemporary

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players, printers, and other gadgets. Devices with Wi-Fi capabilities can wirelessly skulk over LAN networks and disappear into cyberspace. Long range (or point) range is longer outdoors and is roughly 20 meters (66 ft) indoors. An Internet-connected wireless network's capacity can be expanded by using a Wi- Fi subject to connect more devices.

# 4 Software design

Three components make up the proposed WSN-based water quality monitoring system:

- IoT platform
- Big data analysis and water quality control using neural network models.
- Monitoring the quality of the water in real-time using big data analytics incorporated.

## 4.1 IoT Platform

A standard parameter is a labeled data set containing the desired output from a particular combination of inputs. A neural network produces outputs that divide water quality into three categories: risky, cautious, and good. On a Hadoop cluster, the categorization layer operates. Artificial neural networks (ANNs) are a benefit of neural network- based analysis because they are excellent at learning and modelling nonlinear relationships and highly variable data. Despite the fact that neural networks are prone to overfitting, the neural network models used in water monitoring systems are not complex enough to cause overfitting problems. There are other ways to prevent overfitting as well. Additionally, because there are not many parameters that affect water quality, computational load does not slow down system responsiveness.Water turbulence measurement, water pH measurement, and matching water temperature verification are performed using turbidity sensors, pH sensors, and temperature sensors that are all directly coupled to microcontrollers. The data is gathered and processed by a microcontroller using a Wi-Fi module. Data is transmitted from an ESP8266 Wi-Fi module to a PC for examination. Accordingly, the output was likewise displayed on the LCD screen. b) A Hadoop cluster powers classification in the IoT platform layer.

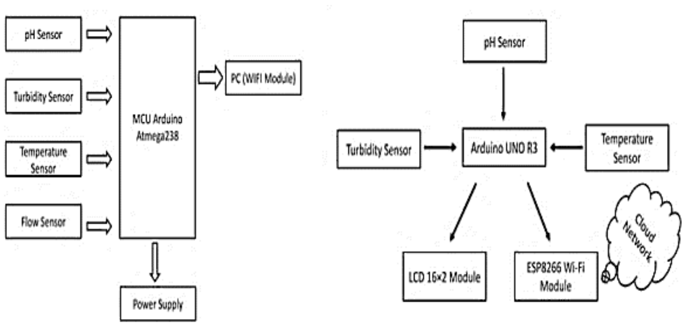


**Fig. 2.** Block diagram of water quality monitoring system

## 4.2 Big data analysis and water quality control using neural network models

Long-term research has been done on the application of artificial neural networks to forecast water quality metrics. A multi-layer neural network model with five inputs is shown below. The output layer's one input layer contains five inputs: In 1, In 2, In 3, In 4, In 5. It has one hidden state with four neurons and three neurons. A hidden layer neuron, an output layer neuron, and two biased input neurons are all coupled. Figure 3 depicts the multi-layer perceptron model created in Neuroph Studio in detail. pH, temperature, turbidity, ORP, and conductivity are the 5 inputs while harmful, caution, and good are the 3 outputs of the neural network model. We must select more parameters before we train the neural network model. Backpropagation learning method, bias input of 1, randomly assigned connection weights, sigmoid function as the activation function, etc. A sigmoid function neuron with the inputs Xj, weights Wj, and bias b produces the result:

A Neuroph Studio-created multi-layer perceptron model. Above is a multi-layer neural network model with five inputs. Layers of input: 1, 2, 3, 4, and 5. In a buried layer with 4 and 3 neurons, the output layer. A hidden layer neuron, an output layer neuron, and two biased input neurons are all coupled. A labelled data set with the desired output from a certain set of inputs is referred to as a quality parameter. An output from a neural network categorizes water quality as good or terrible.

$$\boldsymbol{F}(\boldsymbol{X}) = \mathbf{1}/[\mathbf{1} + \boldsymbol{exp}(-\boldsymbol{\Sigma jwjxj} - \boldsymbol{b})] \quad (1)$$

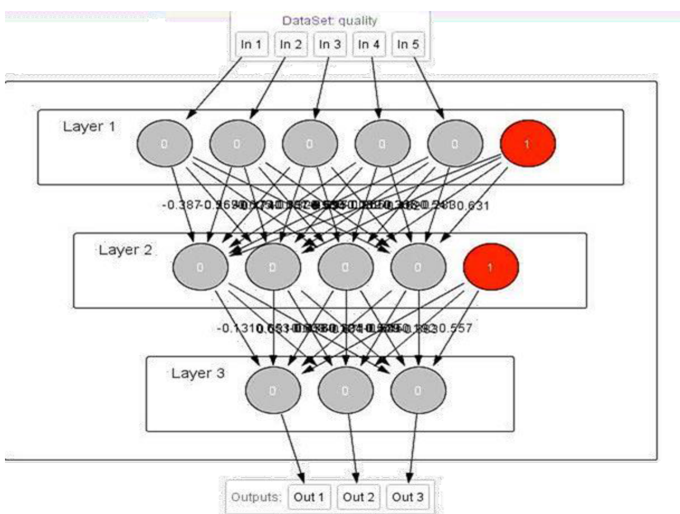


**Fig. 3**. Multilayer perceptron model

### 4.3 Monitoring the quality of the water in real-time using big data analytics incorporated

In equation (1), IoT devices make use of variety of sensors continuously to gather information from river water about turbidity, ORP, temperature, pH, conductivity, etc. The data that IoT devices have acquired can be wirelessly transmitted to a far-off data aggregator server in the cloud. Furthermore, big data analytics solutions are the only ones that can effectively store and continually evaluate the growing volume of semi- structured data.The system needs to be trustworthy and expandable. As a result, an Apache Hadoop cluster is used to deploy and operate the data management layer. Hadoop aids in the distributed processing and storing of large amounts of data across numerous computer clusters. An additional benefit of this operational environment is horizontal scalability. H. The cluster can later add nodes or processors as the volume and speed of data streaming grows. Because jobs are immediately forwarded to the active node in the event of a node failure, Hadoop clusters are fault tolerant. Because several copies of the data are kept on

NameNodes, standby NameNodes, Journal Nodes, and Data Nodes controlled by a failover controller, Hadoop data is extremely accessible. Fast data read/write speeds and excellent database data availability are necessary for IoT applications. Because HBase is a Hadoop component, the system uses it to store massive amounts of data. Thus, data is dispersed using the Hadoop Distributed File System (HDFS). HBase can also run batch processing and real-time queries. HBase offers high availability due to the HDFS storage of data. Numerous machines controlled by Apache Zookeeper make up a Hadoop cluster.

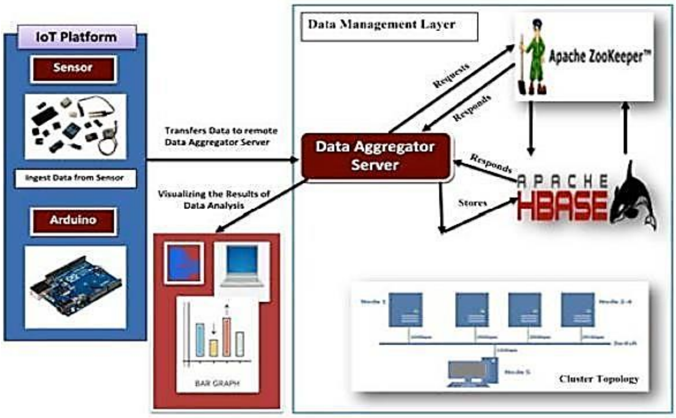


**Fig. 4.** Integration of a data management layer structure.

To provide synchronization services and configuration management amongst nodes, such clusters must be managed centrally. Applications can build znodes in Zookeeper, which are files that store the cluster's state in memory. By registering with znodes and utilizing Zookeeper znodes to share and update node state changes, nodes synchronize task execution across the cluster. Apache Zookeeper oversees Apache HBase. The Internet of Things application enables users to view the results of the data management layer's examination of the water quality over various time series in real-time. Applications for data visualization are operated on client devices such PCs, laptops, and smartphones. From the data management layer, a root user can build daily, monthly, and annual water quality reports and display them on clients'. An IoT water quality monitoring station. IoT devices continuously detect the turbidity, ORP, temperature, pH, conductivity, and other properties of river water. A collection of gathered data can be wirelessly streamed from an IoT device to a cloud-based data aggregator server. Big data analytics programs effectively store and analyze it. As a result, cloud- based apps operating on PCs, laptops, and mobile devices can receive the analysis results from the Data Aggregator Server.

## 5 Proposed system

The primary objective is to provide a method for wireless sensor system with low power dissipation, cheap cost, and high detection accuracy to continuously monitor river water quality in remote areas. To enhance water quality, limits such as pH, conductivity, turbidity, and others are examined. Utilizing remotely accessible sensors, this idea's implementation aims to (a) measure water characteristics like pH, dissolved oxygen, turbidity, and conductivity. (b) data collection from several sensor nodes wireless transmission to a base station (c) Quality parameters are simulated and evaluated for quality assurance.(d) periodically sends SMS to endorsed personnel if the detected quality of water fails to meet the required excellence, allowing them to take the necessary action.

## 6 Results and discussion

The system was tested under various circumstances with various water qualities. The system's output was effective and satisfied our study objectives. Sensor readings are recorded on the prototype device's LCD screen, as was already indicated. The LCD monitor shows the pH temperature of the water as well as the level of turbidity in the tank when an irregularity in the water is discovered. An alert is also activated. People's access to clean drinking water has been severely compromised by a lack of available supplies, pressing financial needs, population increase, urbanization of rural areas, and excessive salt extraction from marine resources. An intelligent water quality monitoring system is an essential tool for continuing water quality monitoring.

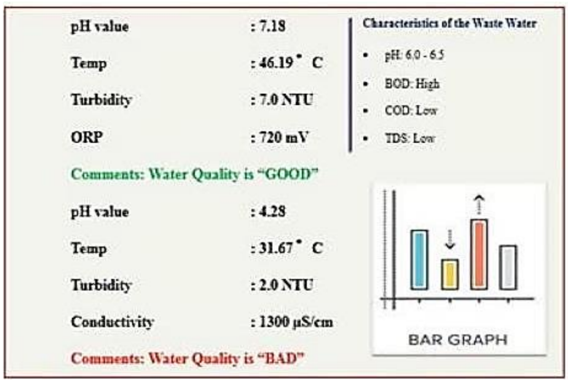


**Fig. 5**. The recorded pH, temperature, turbidity, and ORP values are displayed

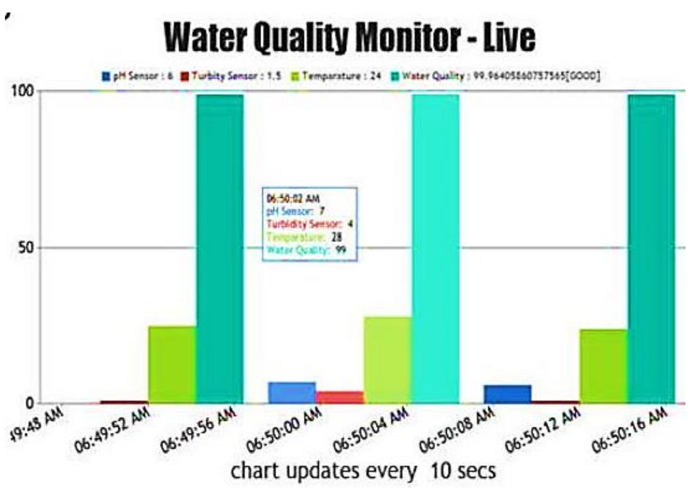


**Fig.6**. Sensor data is represented as a time series

It continuously gathers data on pH, temperature, turbidity, and ORP and shows the results in real time on an LCD, a PC, or a mobile device. The comment will be shown as "POOR" if the recorded value is higher than the cutoff. The comment will be shown as "GOOD" if the recorded value falls below the cutoff. A bar graph and a line graph are also included for easier comprehension.

## 7 Conclusion and future works

Consuming IoT-integrated big data analytics for real-time water quality monitoring can assist people avoid using polluted water and stop water pollution. This study focuses on the continuous assessment of river water quality. Big data analytics with IoT integration, which can offer dependability, scalability, speed, and permanence, appears to be a better answer. During the project development stage, extensive comparative assessments of real-time analytics technologies such as Spark streaming analytics utilizing Spark MLlib, deep learning neural network models, and BRB (Belief Rule Based) systems will be performed. This study advises Bangladeshi river water of various classes to be used in systematic trials using the suggested method. Budget restrictions force us to limit our attention to measuring river water quality metrics. Water pollution is a serious challenge to all nations, harming economies and biodiversity while also having an impact on people's health. The causes and consequences of water contamination are discussed in this paper along with a thorough discussion of the numerous techniques used to check the quality of the water and an effective IoT-based technique. Although there are many outstanding intelligent systems for monitoring water quality, the field of study is still difficult. This paper describes recent efforts by researchers to develop intelligent, low-power, and highly effective water quality monitoring systems, in order to enable continuous monitoring and alerts/notifications to be delivered to relevant authorities, necessitating further action. The development model is affordable and straightforward (flexible). To categorize drinking water, evaluate three samples of water. In the future, we will detect a wide range of additional water quality characteristics using the most recent sensors, enhance communication using wireless communication standards and develop better water quality monitoring systems using IoT for quicker reaction.

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