Real-Time River Water Quality Monitoring and Control System Literature Review

ABSTRACT:

The need for effective and efficient monitoring, evaluation and control of water quality in residential area has become more demanding in this era of urbanization, pollution and population growth. Ensuring safe water supply of drinking water is big challenge for modern civilization. Traditional methods that rely on collecting water samples, testing and analyses in water laboratories are not only costly but also lack capability for real-time data capture, analyses and fast dissemination of information to relevant stakeholders for making timely and informed decisions. In this paper, a real time water quality monitoring system prototype developed for water quality monitoring in Residential home is presented. The development was preceded by evaluation of prevailing environment including availability of cellular network coverage at the site of operation. It detects water temperature, dissolved oxygen, pH, and electrical conductivity in real-time and disseminates the information in graphical and tabular formats to relevant stakeholders through a web-based portal and mobile phone platforms. The experimental results show that the system has great prospect and can be used to operate in real world environment for optimum control and protection of water resources by providing key actors with relevant and timely information to facilitate quick action taking.

INTRODUCTION:

The environment around consists of five key elements e.g., soil, water, climate, natural vegetation, and landforms. Among these, water is the utmost crucial element for human life. It is also vital for the persistence of other living habitats. Whether it is used for drinking, domestic use, and food production or recreational purposes, safe and readily available water is the need for public health. So, it is highly imperative for us to maintain water quality balance. Otherwise, it would severely damage the health of the humans and at the same time affect the ecological balance among other species. Water pollution is a foremost global problem which needs ongoing evaluation and adaptation of water resource directorial principle at the levels of international down to individual wells. It has been studied that water pollution is the leading cause of mortalities and diseases worldwide. The records show that more than 14,000 people die daily worldwide due to water pollution. In many developing countries, dirty or contaminated water is being used for drinking without any proper prior treatment. One of the reasons for this happening is the ignorance of public and administration and the lack of water quality monitoring system which makes serious health issues. IoT integrated network if everywhere starting from smart cities, smart power grids, and smart supply chain to smart wearable. Though IoT is still under applied in the field of environment it has huge potential. It can be applied to detect forest fire and early earthquake, reduce air population, monitor snow level, prevent landslide, and avalanche etc. Moreover, it can be implemented in the field of water quality monitoring and controlling system. Water quality monitoring has gained more interest among researchers in this twenty-first century.

Numerous works are either done or ongoing in this topic focusing on various aspects of it. The key theme of all the projects was to develop an efficient, cost-effective, real-time water quality monitoring system which will integrate wireless sensor network and internet of things. In this research, we monitor the physical and chemical parameters of water bodies inside Chittagong city by using an IoT based sensor network.

EXISTING WORKS:

[1] Pasika and Gandla proposed a monitoring system which consists of a number of sensors used to measure several quality parameters like turbidity, pH value, water level in the tank, dampness of the adjoining environment and temperature of the water. The sensors are interfaced with the Microcontroller Unit (MCU) and additional processing is executed by the Personal Computer (PC). The acquired data will be directed to the cloud by means of Internet of Things (IoT) based ThinkSpeak application for monitoring the quality of the water under test. As a future directive, work should be extended for analyzing some other parameters such as nitrates, electrical conductivity, dissolved oxygen in the water and free residual chlorine.

[2] Mukta et al. developed an IoT based Smart Water Quality Monitoring (SWQM) system which helps in incessant measurement of quality of water on the basis of four different parameters of water quality i.e., pH, temperature, turbidity and electric conductivity. Four different sensors are coupled to Arduino Uno in order to sense the quality parameters. The data collected from all the four sensors are communicated to a desktop application which is developed in .NET platform and the extracted data are matched with the standard values. On the basis of the collected data from sensors, the developed SWQM model will efficaciously examine the water quality parameters by employing fast forest binary classifier for classification of the sample of water under test is whether potable or not.

[3] Konde and Deosarkar proposed a method for developing a Smart Water Quality Monitoring (SWQM) system with reconfigurable sensor interface device using IoT environment. Sensors, Field Programmable Gate Array (FPGA) board, Zigbee based wireless communication module were used in the proposed model. Six different water quality parameters like turbidity, pH, humidity, water level, water temperature and carbon dioxide (CO2) on the surface of water were considered in real-time. The proposed method will provide assistance in guarding the safer and balanced environment of water bodies. The SWQM system reduces the cost and time in determining the quality of water in water resources as part of managing environmental and ecological balance. In the suggested future work, WSN network will be developed involving of additional number of nodes to encompass the coverage area.

[4] In 2007, Stephen Brosnan investigated a wireless sensor network (WSN) to collect real time water quality parameters (WQP).

[5] In 2010, Quio Tie-Zhn developed online water quality monitoring system based on GPRS/GSM. By means of GPRS network information was sent, which helped to check remotely the WQP.

[6] In 2011, Kamal Alamehpresented web based WSN for monitoring water pollution using ZigBee and WiMAX networks. The system measured various WQP and collected, processed

measured data from sensors, and directed through ZigBee gateway to the web server by means of WiMAX network to monitor quality of water from large distances. This System was also capable of monitoring water pollution in real time.

[7]. The remote sensor was based on ZigBee network. WQP tested by WSN and sent data to Internet using GPRS. Information was gathered at remote server, with the help of Web.

[8] In 2013, Kulkarni Amruta created solar powered WQM utilizing remote sensor network. Base station gathers the information from distant remote sensors. Also the BS associated with ZigBee module was powered by sunlight baseboard (Energy harvesting).

pH sensor:

The pH of thing is a useful constant to display because graduate and low pH levels can hump large effects on the author. The pH of a statement can grasp from 1 to 14. A pH sensor is an instrumentation that measures the hydrogen-ion density in a bleach, indicating its tartness or alkalinity. Its constitute varies from 0 to 14 pH.

IoT Platform:

The quality parameters are labeled datasets including desired outputs of specific combination of inputs. The neural network will produce output to classify water quality as dangerous, be careful, and good. The classification layer will run on top of Hadoop cluster [17]. The advantages of using neural network based analytics are like Artificial Neural Networks (ANNs) are good in learning and modeling non-linear relationships, and high volatile data [18]. Though neural networks are prone to over fitting, the neural network model used in water quality monitoring system is not complex enough to cause over fitting problem. Also, there are many countermeasures to avoid over fitting. Also, computation overload is not going to delay the response of system as there are only a few water quality parameters.

Real-time monitoring of water quality by using IoT integrated Big Data Analytics:

IoT devices use various types of sensors to collect data about turbidity, ORP, temperature, pH, conductivity, etc. of river water continuously. Also, IoT devices have capability to stream the array of collected data wirelessly to the remote Data Aggregator Server in the cloud. Moreover, the volume of semi structured data increases with time in such a velocity that only the Big Data Analytics applications can efficiently store and analyze the data constantly [18]. The system should be reliable and scalable. So, data management layer will be deployed and operational on the Apache Hadoop cluster. Hadoop helps distributed storing and processing of big data across cluster of computers. Also, such operational environment is horizontally scalable i.e. nodes or computers can be added to a cluster later while volume and velocity of data streaming will be increasing. Hadoop cluster is fault tolerant as jobs are redirected

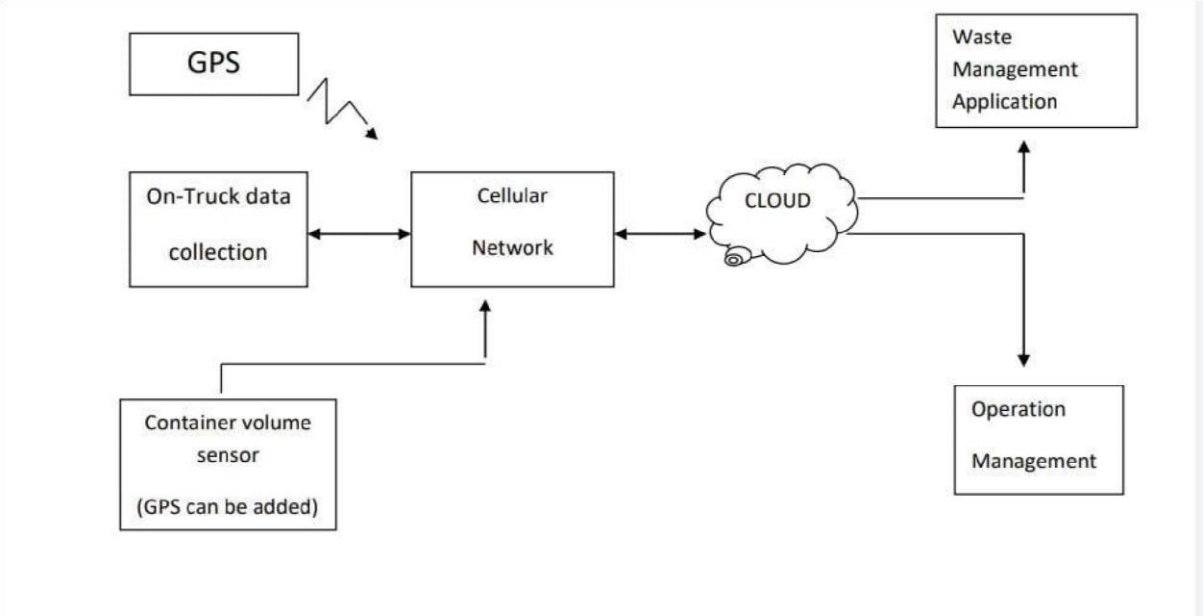
automatically to the running nodes when nodes are failed. The data in Hadoop is highly available as multiple copies of data are stored in data nodes managed by name node, standby name node, journal nodes and failover controller. IoT applications need high speed of read/write of data and highly available data.

Solution Architecture:

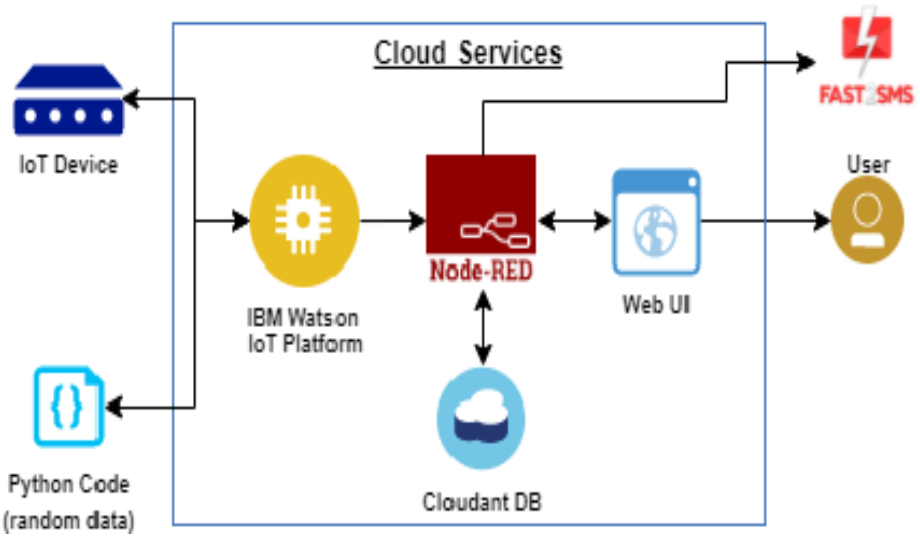
Solution architecture: A complicated with numerous sub-processes, – solution architecture connects technological remedy to business issue. Its objectives are to

- Find the best tech solution to solve existing business problems.
- Explain to project stakeholders the structure, traits, behaviour, and other features of the software.
- Specify the project's features, development stages, and solution needs.
- Offer the requirements by which the solution is created, handled, and given to the clients.

Solution Architecture Diagram:



Cloud Service:



Proposed Solution Template:

Project team shall fill the following information in proposed solution template.

S.No.	Parameter	Description
1.	**Problem Statement (Problem to be solved)**	Massive growth of algae called eutrophication leads to pollution. To Control the Algal bloom and monitor the water parameters such as ph, turbidity and dissolved solvents.
2.	**Idea / Solution description**	Detecting the dust particles, PH level of water, Dissolved oxygen and temperature to be monitored and altering the authorities if water quality is not good.
3.	**Novelty / Uniqueness**	River water quality can be monitored by web application. Quality parameter will track continuously with standard measurements.
4.	**Social Impact / Customer Satisfaction**	Localities will not get suffered by poor quality of water by alerting them when the water quality is not good.

5.	**Business Model (Revenue Model)**	Water quality monitoring system by Aeron systems for industrial water treatment plant, river bodies. Aqua forming digital loggers.
6.	**Scalability of the Solution**	Measuring of real time values and continuous monitoring helps in maintaining the quality of water.

Problem Solution Fit:

Outcomes:

PYTHON PROGRAM:-

```
import time import sys
importibmiotf.application
import ibmiotf.device import random
```

#Provide your IBM Watson Device

```
Credentials organization = "7wqirt" deviceType
= "raspberrypi" deviceId = "12345" authMethod
= "token" authToken = "123456789"
try:
        deviceOptions = {"org": organization, "type": deviceType, "id": deviceId, "auth-method":
 authMethod, "auth-token": authToken} deviceCli = ibmiotf.device.Client(deviceOptions)
    #.....
 except Exception as e:  print("Caught exception connecting device: %s"
% str(e)) sys.exit()
```

Connect and send a datapoint "hello" with value "world" into the cloud as an event of type

```
"greeting" 10 times deviceCli.connect() while
True:
```

#Get Sensor Data from randam value function

```
temp=random.randint(0,50) ph=random.uniform(0.0,14.0)  turb=random.uniform(0.0,3.0)


data1={'temp':temp,'ph':ph,'turb':turb,'str1':"Not safe to drink"}
data2={'temp':temp,'ph':ph,'turb':turb,'str2':"safe to drink"}
```

```
#print data  def
        myOnPublishCallback():
                        print ("Published Temperature = %s C" % temp,"Ph = %.1f " % ph,"Turbidity = %.1f
 NTU" % turb, "to IBM Watson")
              if((temp > 6 and temp < 20) and (ph > 6.5 and ph < 8.5) and turb < 1):
                    print(data2) else:
                    print(data1)




        success = deviceCli.publishEvent("IoTSensor", "json", data1 or data2, qos=2,
on_publish=myOnPublishCallback)




        if not success:
           print("Not connected to IoTF")  time.sleep(20)
```

 # Disconnect the device and application from the cloud deviceCli.disconnect()

Result:

we are displaying the resulting sensed pH, temp, turbidity, and ORP values. It continuously senses the values of pH, temp, turbidity, and ORP and the resulting values are displayed to the LCD, PC or mobile in real-time. If the acquired value is above the threshold value comments will be displayed as 'BAD'. If the acquired value is lower than the threshold value comments will be displayed as 'GOOD'. A bar/line graph will also be shown for perfect understanding. The time series representation of sensor data with decision the resulting sensed pH, temp, turbidity, and ORP values. It continuously senses the values of pH, temp, turbidity, and ORP and the resulting values are displayed to the LCD, PC or mobile in real-time. If the acquired value is above thelue comments will be displayed as 'GOOD'. A bar/line graph will also be shown for perfect understanding.

Conclusions and future works :

Real-time monitoring of water quality by using IoT integrated Big Data Analytics will immensely help people to become conscious against using contaminated water as well as to stop polluting the water. The research is conducted focusing on monitoring river water quality in real-time. Therefore, IoT integrated big data analytics is appeared to be a better solution as reliability, scalability, speed, and persistence can be

provided. During the project development phase an intense comparative analysis of real-time analytics technologies such as Spark streaming analysis through Spark MLlib, Deep learning neural network models, and Belief Rule Based (BRB) system will be conducted [20-27]. This research would recommend conducting systematic experimentation of the proposed technologies in diverse qualities of river water in Bangladesh.

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