IBM PROJECT

Real-Time River Water Quality Monitoring and Control System

BATCH : B3-3M5E

TEAM ID : PNT2022TMID32043

TEAM LEADER : Ragavan GV

TEAM MEMBERS:

1. **Vetrikumar V**
2. **Ruban Nisanth B**
3. **Vinith KA**

7. **CODING & SOLUTIONING (Explain the features added in the project along with code)**
   - 7.1 Feature 1
   - 7.2 Feature 2
   - 7.3 Database Schema (if Applicable)
8. **TESTING**
   - 8.1 Test Cases
   - 8.2 User Acceptance Testing
9. **RESULTS**
   - 9.1 Performance Metrics
10. **ADVANTAGES & DISADVANTAGES**
11. **CONCLUSION**
12. **FUTURE SCOPE**
13. **APPENDIX**

    Source Code

    GitHub & Project Demo Link

1.INTRODUCTION :

1.1 PROJECT OVERVIEW:

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 . In this paper, we depict the design of Wireless Sensor Network (WSN) that assists to monitor the quality of water with the support of information sensed by the sensors dipped in water. Using different sensors, this system can collect various parameters from water, such as pH, dissolved oxygen, turbidity, conductivity, temperature, and so on. The rapid development of WSN technology provides a novel approach to real-time data acquisition, transmission, and processing. The clients can get ongoing water quality information from far away. Now a day's Internet of things (IoT) is an innovative technological phenomenon.

It is shaping today's world and is used in different fields for collecting, monitoring and analysis of data from remote locations. 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.

1.2 PURPOSE:

The aim of the device is to check the quality of water. This device deals with the system that is developed to measure the parameters of water such as turbidity,dissolved solvents,pH and temperature.The contamination level of water has been determined by comparing the obtained parameters with their respective ideal ranges.The sensors are interfaced with Arduino UNO and Raspberry Pi for data processing and transmission.The device is designed to float on the water body there by transmitting the measured data trough Wi-Fi to the remote place.The developed water quality monitoring system requires 17 Watts of on-board power and takes 8sec of time for complete processing of one set of data. Environmental impacts in surface waters include algal blooms and disruption to ecological function.Strategies for protection of rivers from eutrophication include improved agricultural land management,conservation farming methods,recycling or retention of drainage and runoff water,The treatment processes were studied using

ultrasonic frequencies;20,40 and 60 Khz at different time intervals namely 15,30,45 and 60 minutes.

2.LITERATURE SURVEY:

2.1 EXISTING PROBLEM:

Current water quality monitoring system is a manual system with a monotonous process and is very time-consuming. This paper proposes a sensor-based water quality monitoring system. The main components of Wireless Sensor Network (WSN) include a micro-controller for processing the system, communication system for inter and intra node communication and several sensors. Real-time data access can be done by using remote monitoring and Internet of Things (IoT) technology. Data collected at the apart site can be displayed in a visual format on a server PC with the help of Spark streaming analysis through Spark MLlib, Deep learning neural network models, Belief Rule Based (BRB) system and is also compared with standard values. If the acquired value is above the threshold value automated warning SMS alert will be sent to the agent. The uniqueness of our proposed paper is to obtain the water monitoring system with high frequency, high mobility, and low powered. Therefore, our proposed system will

immensely help Bangladeshi populations to become conscious against contaminated water as well as to stop polluting the water.

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. The system consists of a Raspberry Pi, Analog to Digital Converter, Water quality measurement sensors. 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.

2.2 REFERENCES:

1. K. S. Adu-Manu, C. Tapparello, W. Heinzelman, F. A. Katsriku, and J.-D. Abdulai, "Water quality monitoring using wireless sensor networks: Current trends and future research directions," ACM Transactions on Sensor Networks (TOSN), vol. 13, p. 4, 2017.

2. B. Chen, Y. Song, T. Jiang, Z. Chen, B. Huang, and B. Xu, "Real-time estimation of population exposure to PM2.5 using mobile- and station-based big data," Int J Environ Res Public Health, vol. 15, Mar 23 2018.

3. B. Paul, "Sensor based water quality monitoring system," BRAC University, 2018.

4. K. Andersson and M. S. Hossain, "Smart Risk Assessment Systems using Belief-rule-based DSS and WSN Technologies", in 2014 4th International Conference on Wireless Communications, Vehicular Technology, Information Theory and Aerospace and Electronic

Systems, VITAE 2014 : Co-located with Global Wireless Summit, Aalborg, Denmark 11-14 May 2014, 2014.

5. S. Thombre, R. U. Islam, K. Andersson, and M. S. Hossain, "IP based Wireless Sensor Networks : performance Analysis using Simulations and Experiments", Journal of Wireless Mobile Networks, Ubiquitous Computing, and Dependable Applications, vol. 7, no. 3, pp. 53–76, 2016.

6. K. Andersson and M. S. Hossain, "Heterogeneous Wireless Sensor Networks for Flood Prediction Decision Support Systems", in 2015 IEEE Conference on Computer Communications Workshops (INFOCOM WKSHPS) : 6th IEEE INFOCOM International Workshop on Mobility Management in the Networks of the Future World, 2015, pp. 133–137.

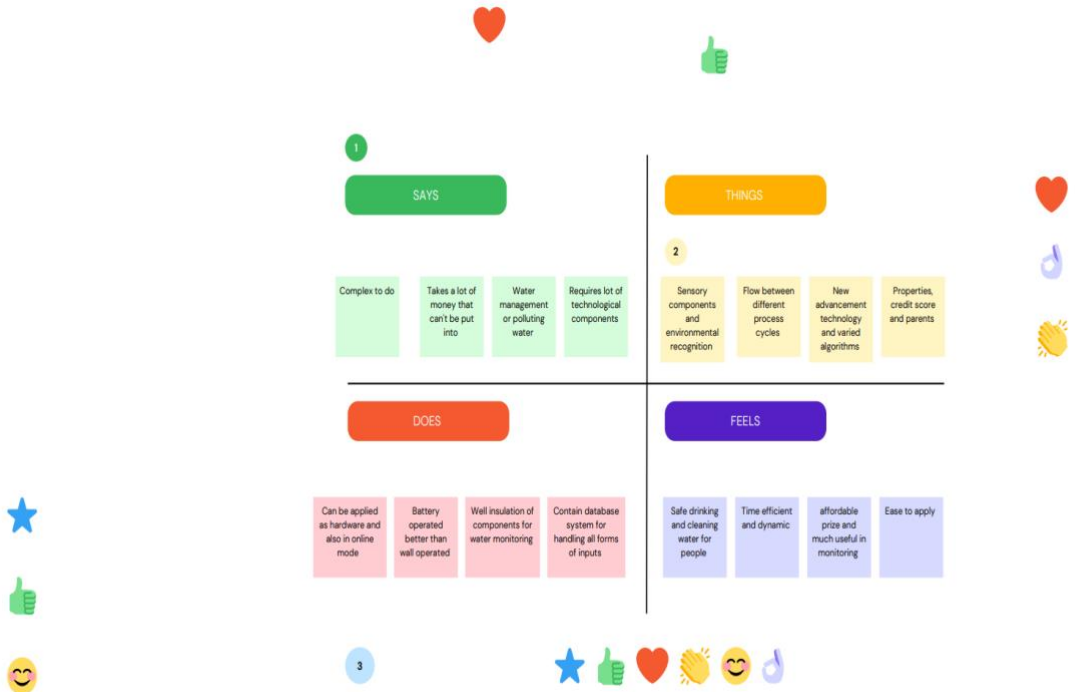
2.3 PROBLEM STATEMENT DEFINITION:

Due to the fast growing urbanization supply of safe drinking water is a challenge for the every city authority. Water can be polluted any time. So the water we reserved in the water tank at our roof top or basement in our society or apartment may not be safe. Still in India most of the people use simple water purifier that is not enough to get surety of pure water. Sometimes the water has dangerous particles or chemical mixed and general purpose water purifier cannot purify that.

And it’s impossible to check the quality of water manually in every time. So an automatic real-time monitoring system is required to monitor the health of the water reserved in our water tank of the society or apartment. So it can warn us automatically if there is any problem with the reserved water. And we can check the quality of the water anytime and from anywhere. By keeping this mind we designed this system especially for residential areas.

3.IDEATION & PROPOSED SOLUTION:

3.1 EMPATHY MAP CANVAS:



3.2 IDEATION & BRAINSTORMING:

3.2.1 DEFINE PROBLEM STATEMENT:

Nowadays the peoples in the world are unpurified river waters and facing many health issues.

3.2.2 BRAINSTROME:

RAGAVAN GV

- Continues monitoring archived through Web UI
- All requirements stored through an external SD card
- Quick access through the interface
- Results monitored via cloud service

RUBAN NISANTH B

- Eco friendly
- Doesn't require much experience to use
- An powerful equipment that provides clean river water

VETRIKUMAR V

- Profitable
- Much Faciliated
- Much Faciliated

VINITH KA

- Boosts confdence among people using river source
- Has great user interface and is trust worth to use
- Gives accurate Values

3.2.3 GROUP IDEAS:

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. Uttermost pH values also process the solubility of elements and compounds making them cyanogenetic. Mathematically pH is referred as, pH = -log [H+].

TEMPERATURE SENSOR:

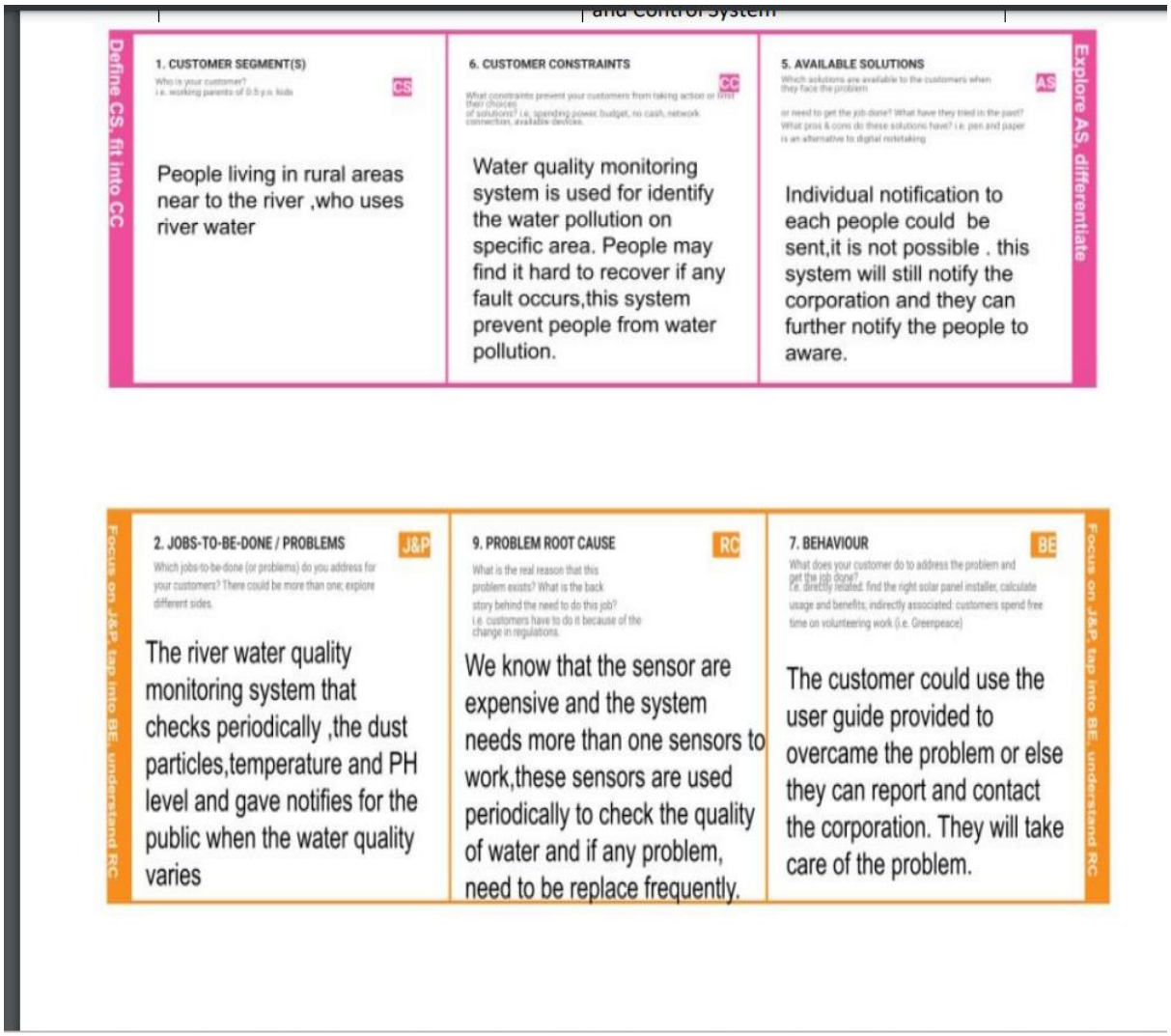
Here DS18B20 is old as the temperature device. Usually, its present use to perceive the temperature of the life, if we site the device wrong the conductor electrode and placed into the H2O, it can discover the temperature of H2O also. The normal temperature of the people is (25 -30)°C.

3.2.4 PRIORITIZE:

3.3 PROPOSED SOLUTION:

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	Massive growth of algae called eutrophication leads to pollution(monitoring and controlling the quality of river water)
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.

3.4 PROBLEM SOLUTION FIT:



4. REQUIREMENT ANALYSIS:

4.1 FUNCTIONAL REQUIREMENTS:

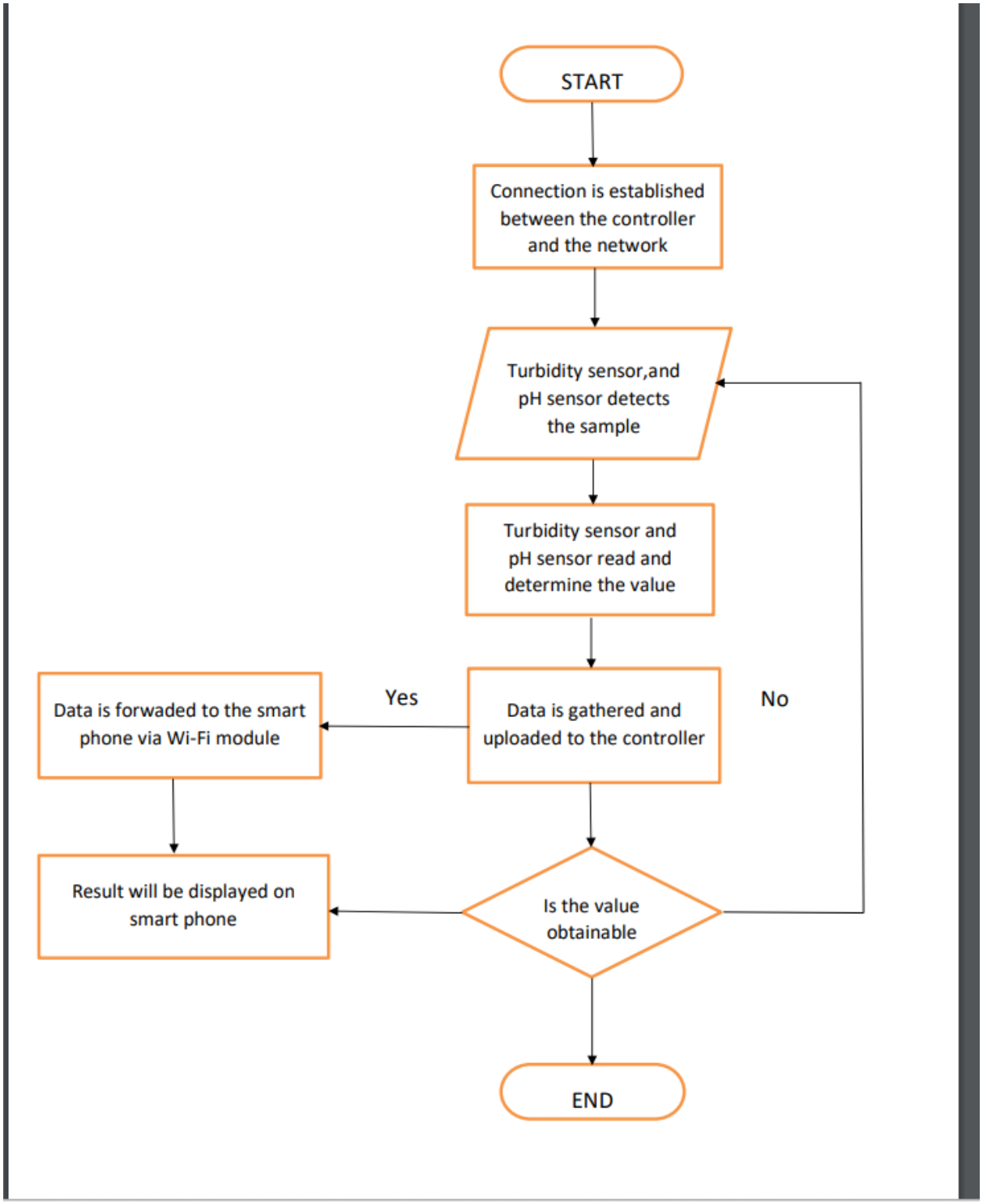
FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	User Registration	Registration through Form Registration through Gmail Registration through product mobile UI
FR-2	User Confirmation	Confirmation via Email Confirmation via OTP
FR-3	Ph level detection	Ph sensor is used to monitor the water quality and the signals are send to Arduino.
FR-4	Turbidity detection	Turbidity sensor TS-300B measures the turbidity (counter of suspended matter) in the wash water and the signals are send to Arduino.
FR-5	Ultrasonic generator	Waves generated at regular interval times to clear algae 25% ,50%, 100%

4.2 NON FUNCTIONAL REQUIREMENTS:

FR No.	Non-Functional Requirement	Description
NFR-1	**Usability**	Efficient to use and has simple monitoring system.
NFR-2	**Security**	Mobile application is secured with firewalls protection
NFR-3	**Reliability**	Real time sensor output values with future predicted data storage.98% efficient monitoring output . Assurance for aquaculture safety
NFR-4	**Performance**	Greater performance and environmental safe model
NFR-5	**Availability**	In form of mobile UI 24 x 7 monitoring system
NFR-6	**Scalability**	Highly Scalable.It is capable to produce a best final output.
NFR-7	**Stability**	It is highly stable .
NFR-8	**Efficiency**	It is highly efficient and it has simple monitoring system .

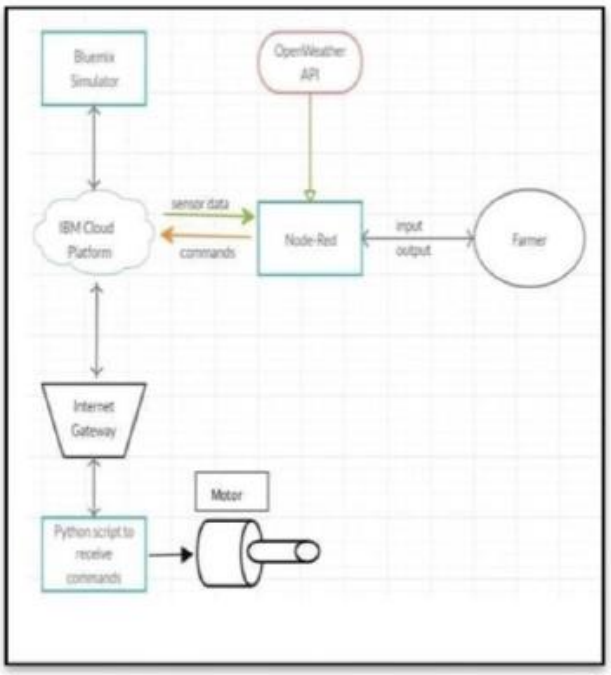
5.PROJECT DESIGN:

5.1 DATA FLOW DIAGRAM:



5.2 TECHNICAL ARCHITECTURE:

TECHNICAL ARCHITECTURE



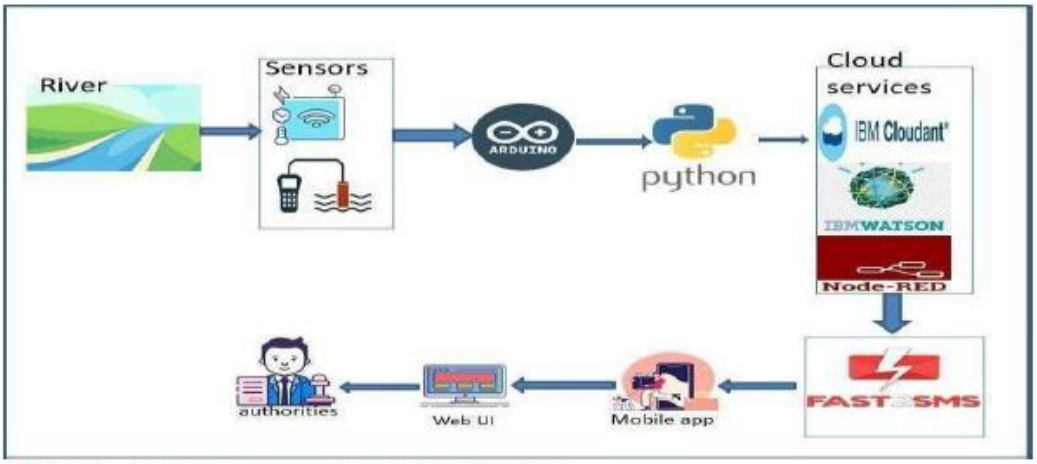


Table-1 : Components & Technologies:

5.3 USER STORIES:

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Customer (Mobile user)	Registration	USN-1	As a user, I can register for the application by entering email, password, and confirming my password.	I can access my account/dashboard	High	Sprint-1
		USN-2	As a user, I will receive a confirmation email once I have registered for the application	I can receive e confirmation email & click confirm	High	Sprint-2
		USN-3	As a user, I can register for the application through Google	I can register & access the dashboard with Google	High	Sprint-1
		USN-4	As a user, I can register for the application through Gmail	I can register through the mail	Medium	Sprint-2
	Login	USN-5	As a user, I can log into the application by entering email, password & captcha	I can receive login credentials.	High	Sprint-1
	Interface	USN-6	As a user, the interface should be user-friendly manner	I can able to access easily.	Medium	Sprint-1
Customer (Web user)	dashboard	WUSN-1	As a web user, I can access the specific info (ph value, temp, humidity, quality).	I can able to know the quality of the water.	High	Sprint-1
Customer Care Executive (input)	View manner	CCE-1	As a customer care, I can view data in visual representation manner(graph)	I can easily understand by visuals.	High	Sprint-1
	Taste	CCE-2	As a customer care , I can able to view the quality(salty) of the water	I can easily know whether it is salty or not	High	Sprint-1
	Color visibility	CCE-3	As a customer care , I can able predict the water color	I can easily know the condition by color	High	Sprint-1
Administrator	Risk tolerant	ADMIN-1	An administrator who Is handling the system should update and take care of the application.	Admin should monitor the records properly.	High	Sprint-2

6.1 SPRINT PLANNING & ESTIMATION:

Sprint	Functional Requirement(Epic)	User Story Number	User Story/Task	Story Points	Priority	Team Members
Sprint 1	Registration	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	2	High	GV. Ragavan
Sprint-1		USN-2	As a user, I will receive confirmation email once I have registered for the application	1	High	B.Ruban nisanth
Sprint-2		USN-3	As a user, I can register for the application through Facebook	2	Low	V. Vetrikumar
Sprint-1		USN-4	As a user, I can register for the application through Gmail	2	Medium	K.A. Vinith

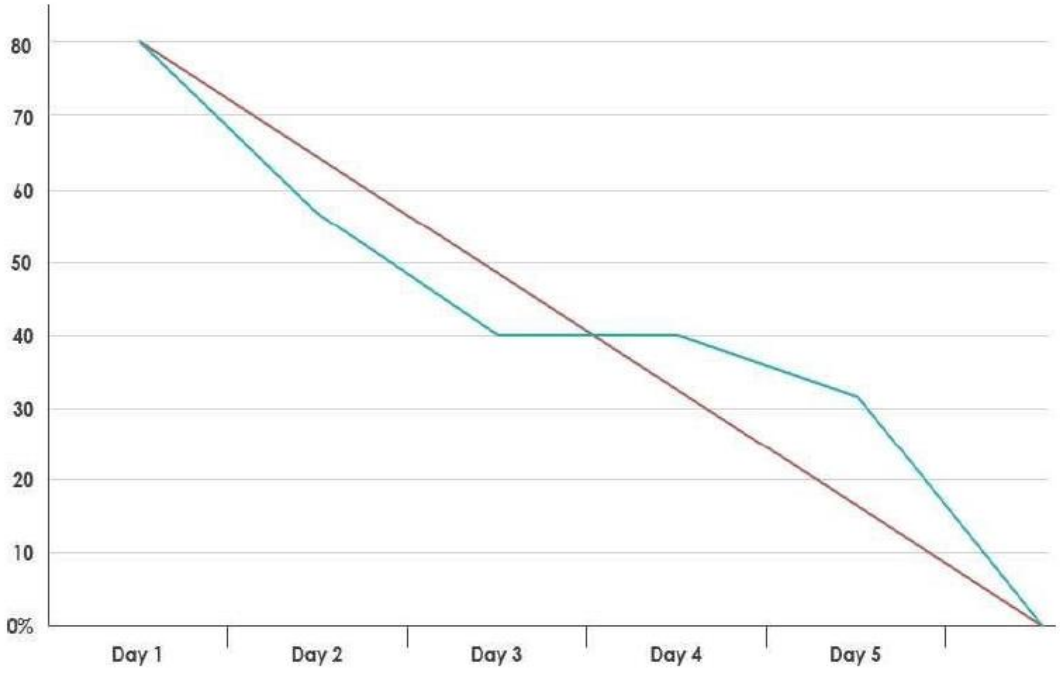
6.2 SPRINT DELIVERY SCHEDULE:

Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date (Actual)
Sprint-1	20	6 Days	24 Oct 2022	29 Oct 2022	20	29 Oct 2022
Sprint-2	20	6 Days	31 Oct 2022	05 Nov 2022	30	30 Oct 2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	49	06 Nov 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	50	07 Nov 2022

Velocity:

$$AV = \frac{sprint\ duration}{velocity} = \frac{20}{10} = 2$$

Burndown Chart:



7. CODING AND SOLUTIONING:

7.1 FEATURE-1:

PYTHON CODE:

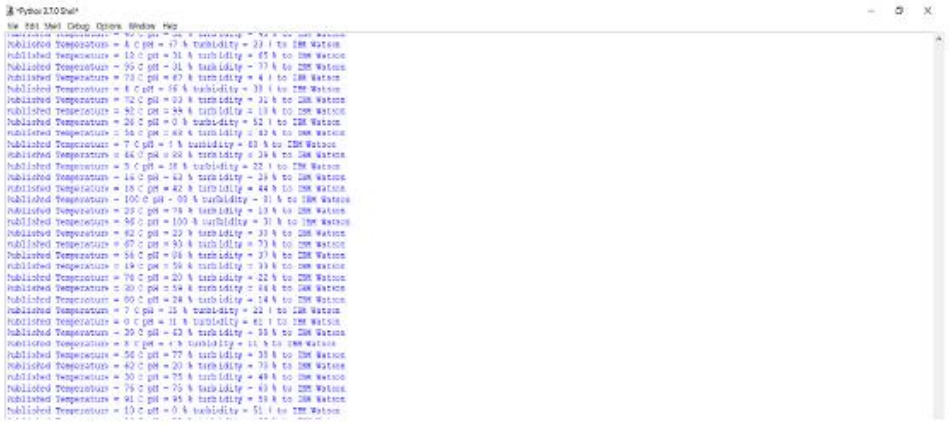
```
import time
import sys
import ibmiotf.application
import ibmiotf.device
import random
#Provide your IBM Watson Device Credentials
organization = "w1nouz"
deviceType = "riverwatermonitor1"
deviceId = "monitorsensor1"
authMethod = "token"
authToken = "!yjEh7zDC6(Cf@s&Rz"
# Initialize GPIO
def myCommandCallback(cmd):
print("Command received: %s" % cmd.data['command'])
status=cmd.data['command']
if status=="Light on":
print ("LED is on")
```

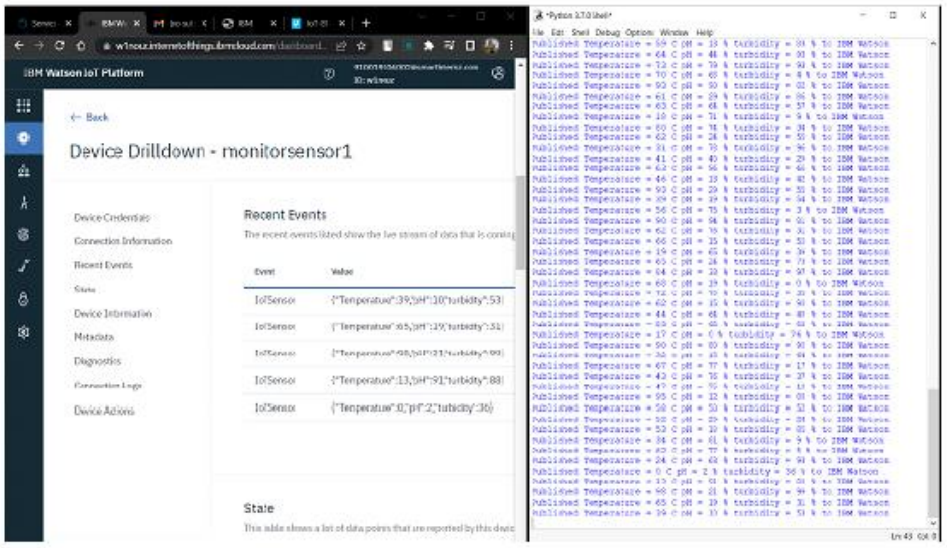
```
else:
print ("LED is off")
#print(cmd)
try:
deviceOptions = {"org": organization, "type": deviceType, "id": deviceId, "auth-method":
authMethod, "auth-token": authToken}
deviceCli = ibmiotf.device.Client(deviceOptions)
#.....
except Exception as e:
print("Caught exception connecting device: %s" % 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 DHT11
temp=random.randint(0,100)
pH=random.randint(0,100)
turbidity = random.randint(0,100)
```

```
data = { 'Temperature' : temp, 'pH' : pH, 'turbidity' : turbidity }
#print data
def myOnPublishCallback():
print ("Published Temperature = %s C" % temp, "pH = %s
%%" % pH, "turbidity = %s %%"
%turbidity ,"to IBM Watson")
success = deviceCli.publishEvent("IoTSensor", "json", data,
qos=0,
on_publish=myOnPublishCallback)
if not success:
print("Not connected to IoTF")
time.sleep(1)
deviceCli.commandCallback = myCommandCallback
# Disconnect the device and application from the cloud
deviceCli.disconnect()
```

7.2 FEATURE-2:

OUTPUT:





8.TESTING:

8.1 TEST CASE:

*** Test cases**

*** User Acceptance Testing**

9.RESULTS:

9.1 PERFORMANCE MATRIX:

Current water quality monitoring system is a manual system with a monotonous process and is very time-consuming. This paper proposes a sensor-based water quality monitoring system. The main components of Wireless Sensor Network (WSN) include a microcontroller for processing the system, communication system for inter and intra node communication and several sensors. Real-time data access can be done by using remote monitoring and Internet of Things (IoT) technology. Data collected at the apart site can be displayed in a visual format on a server PC with the help of Spark streaming analysis through Spark MLlib, Deep learning neural network models, Belief Rule Based (BRB) system and is also compared with standard values. If the acquired value is above the threshold value automated warning SMS alert will be sent to the agent. The uniqueness of our proposed paper is to obtain the water monitoring system with high frequency, high

mobility, and low powered. Therefore, our proposed system will immensely help Bangladeshi populations to become conscious against contaminated water as well as to stop polluting the water.

10.ADVANTAGES:

- Following are the benefits or advantages of IoT based Water Quality Monitoring System are as follows.

➤The boat is mobile in nature and hence large number of samples are easily collected from different locations in less time.

➤It is very easy to maintain the IoT based water quality monitoring system as all the electronic boards are available in the boat itself.

➤The system is very cheap as the hardware and software does not cost much.

➤Machine learning techniques have made it very easy to plot the data collected in various formats for proper analysis.

➤Cloud storage platforms such as adafruit, azure helps in storing the sensor data immediately and wirelessly to the robust servers.

- Water is an essential element of our lives, giving life to all living creatures on Earth.

- The importance of ensuring that this water is of sound quality is extremely important, particularly if that water is intended for consumption.

- Water quality testing can provide valuable data on the condition of a particular body of water, and whether it may need special treatment before use.

- Examing factors such as the pH level, nutrient levels, amount of dissolved oxygen, alkalinity and bacteria are all useful in understanding the health of a waterbody, allowing you to accurately create a water management plan with the data.

This article from ECO Environmental will be examining the advantages of water quality testing, before assessing some of the popular water quality meters available on the market today.

DISADVANTAGES:

- Pure water is the ideal liquid for hydration. However, if you drink pure water along with an unhealthy diet, it may have some disadvantages. For example, if your diet consists primarily of unhealthy food and snacks, drinking pure water will not benefit you much due to the lack of vitamins and minerals in your diet.

- Pure water can also be a disadvantage if you exercise in high temperatures, and you are on a no sodium diet.

- Proper server maintenance is needed.

- **Real-time running errors can’t be neglected**

11.CONCLUSION:

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 . This research would recommend conducting systematic experimentation of the proposed technologies in diverse qualities of river water in Bangladesh.

Due to the limitation of the budget, we only focus on measuring the quality of river water parameters. This project can be extended into an efficient water management system of a local area. Moreover, other parameters which wasn't the scope of this project such as total dissolved solid, chemical oxygen demand and dissolved oxygen can also be quantified. So the additional budget is required for further improvement of the overall system.

12.FUTURE WORKS:

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. Due to the limitation of the budget, we only focus on measuring the quality of river water parameters. This project can be extended into an efficient water management system of a local area. Moreover, other parameters which wasn't the scope of this project such as total dissolved solid, chemical oxygen demand and dissolved oxygen can also be quantified. So the additional budget is required for further improvement of the overall system.

13. APPENDIX:

SOURCE CODE:

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


        #Provide your IBM Watson Device Credentials
        organization = "w1nouz"
        deviceType = "riverwatermonitor1"
        deviceId = "monitorsensor1"
        authMethod = "token"
        authToken = "!yjEh7zDC6(Cf@s&Rz"

        # Initialize GPIO
        def myCommandCallback(cmd):
            print("Command received: %s" % cmd.data['command'])
            status=cmd.data['command']
            if status=="Light on":
```

```
        print ("LED is on")
    else:
        print ("LED is off")

    #print(cmd)
```

```
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 DHT11

        temp=random.randint(0,100)
        pH=random.randint(0,100)
        turbidity = random.randint(0,100)

        data = { 'Temperature' : temp, 'pH' : pH, 'turbidity' : turbidity }
        #print data
        def myOnPublishCallback():
            print ("Published Temperature = %s C" % temp, "pH = %s %%" % pH, "turbidity = %s %%" %turbidity ,"to IBM Watson")

        success = deviceCli.publishEvent("IoTSensor", "json", data, qos=0, on_publish=myOnPublishCallback)
        if not success:
            print("Not connected to IoTF")
        time.sleep(1)

        deviceCli.commandCallback = myCommandCallback

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

GITHUBCODE: https://github.com/IBM-EPBL/IBM-Project-24788-1659948872