DHANALAKSHMI SRINIVASAN COLLEGE OF ENGINEERING,

COIMBATORE – 641105.

PROJECT TITLE: REAL TIME RIVER WATER QUALITY MONITORING AND CONTROL SYSTEM.

Team Leader: Nikil Sandeep. D

Team Members: Rakesh. A, Adhavan. D, Pravin. M

Team Id: PNT2022TMID43902

Industry Mentor: Bharadwaj

Faculty Mentor Name: Mukunthan. S

S.no	Name	Register Number	Mail Id
1	Nikil Sandeep. D	721919106052	nikilsandeep19@dsce.ac.in
2	Pravin. M	721919106056	pravin19@dsce.ac.in
3	Adhavan. D	721919106005	adhavan19@dsce.ac.in
4	Rakesh. A	721919106061	rakesh19@dsce.ac.in

PROJECT REPORT FORMAT

1. INTRODUCTION

1.1 Project Overview

1.2 Purpose

2. LITERATURE SURVEY

2.1 Existing problem

2.2 References

2.3 Problem Statement Definition

3. IDEATION & PROPOSED SOLUTION

3.1 Empathy Map Canvas

3.2 Ideation & Brainstorming

3.3 Proposed Solution

3.4 Problem Solution fit

4. REQUIREMENT ANALYSIS

4.1 Functional requirement

4.2 Non-Functional requirements

5. PROJECT DESIGN

5.1 Data Flow Diagrams

5.2 Solution & Technical Architecture

5.3 User Stories

6. PROJECT PLANNING & SCHEDULING

6.1 Sprint Planning & Estimation

6.2 Sprint Delivery Schedule

6.3 Reports from JIRA

7. CODING & SOLUTIONING (Explain the features added in the project along with code)

REAL TIME RIVER WATER QUALITY MONITORING AND CONTROL SYSTEM.

1. INTRODUCTION:

Nowadays, water quality monitoring faces challenges because of global warming limited water resources, growing population, industrial improvements etc.1]. So there is need to develop a best methodologies to monitor the water quality parameters in real time. Water quality is generally affected due to both point and non-point sources of pollution. Hazardous of various category have got mixed with the drinking water which is produced through the industrialization, globalization, urbanization, agriculture etc. Basically, Poor water quality spreads diseases causes death [1]. Upto 5 million people die due to waterborne diseases in the world.

Basic definition of Water quality monitoring is the collection of information at set locations and at regular intervals in order to provide data which may be used to define current trends. There is need of controlling pollution and the measures for the effectiveness of pollution control in water is finished by monitoring Water quality. Our proposed System consists of various sensors which compute the standard values of water in real-time for effective action and is accurate and only less manpower required [4].

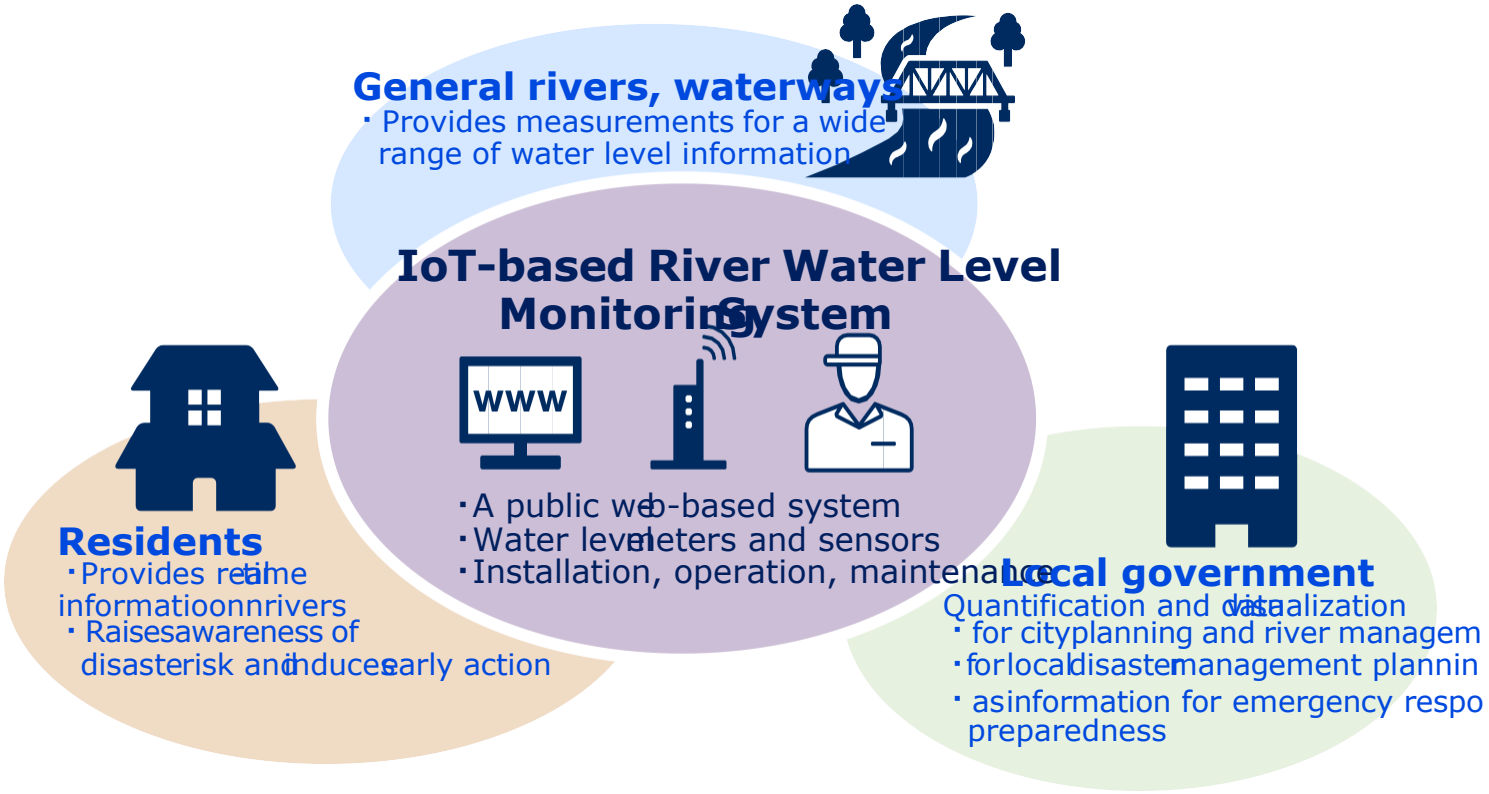
The water quality parameters like pH, it generally measures the concentration of hydrogen ions. It shows whether the current water condition is acidic or alkaline. Pure water has 7 pH value, less than 7 pH has acidic and more than 7 pH has alkaline. The range of pH is 0-14 PH. For drinking purpose it should be 6.5-8.5 pH[1]. The another quality attribute Turbidity measures the large number of suspended particles in water that are invisible. If the turbidity is higher then there is higher risk of diarrhea, collera[1]. On the other hand if turbidity is lower then the water is clean. Temperature sensor measures whether water is hot or cold.

The traditional methods of water quality monitoring involves the manual collection of water samples from different locations. As we will get the solutions of water samples then we can measure the different quality attributes of water and compare them with the given threshold values or standard values, if the values generated from the sensors are exceeded then alert is sent to the user of system and necessary actions will be taken by user.

1.1 Project Overview:

The IoT-based River Water Level Monitoring System uses LPWA* technology to collect real-time data on changes in the water level of rivers. The system can be used to keep communities safe by visualizing the collected data on the Internet.

* LPWA (Low Power Wide Area): wireless communications technologies offering wide-area coverage with low power consumption.



Water level is periodically measured via the dirt-proof, non-contact remote sensor units installed at each river. The sensors do not require a separate power supply and are easy to install.

- The sensors are optimized for use in monitoring the water level of rivers and are designed in a way to prevent them from being washed away and eliminate the need for attachment to revetments.
- Built to withstand the outdoor environment: the sensor's system and structure are designed to be resistant against solar radiation, pressure, and dirt (IP65)
- Environmental considerations: Featuring power-saving and ecological design in every detail, the system's built-in battery can provide roughly five years of operation (calculated value).
- Short construction period: Comes with labor-saving standard DIY mounting kit for attaching the sensors to existing poles and other support structures.

・Aesthetic considerations: Use of built-in batteries rather than solar panels ensures that sensors are compact and require minimal installation space.

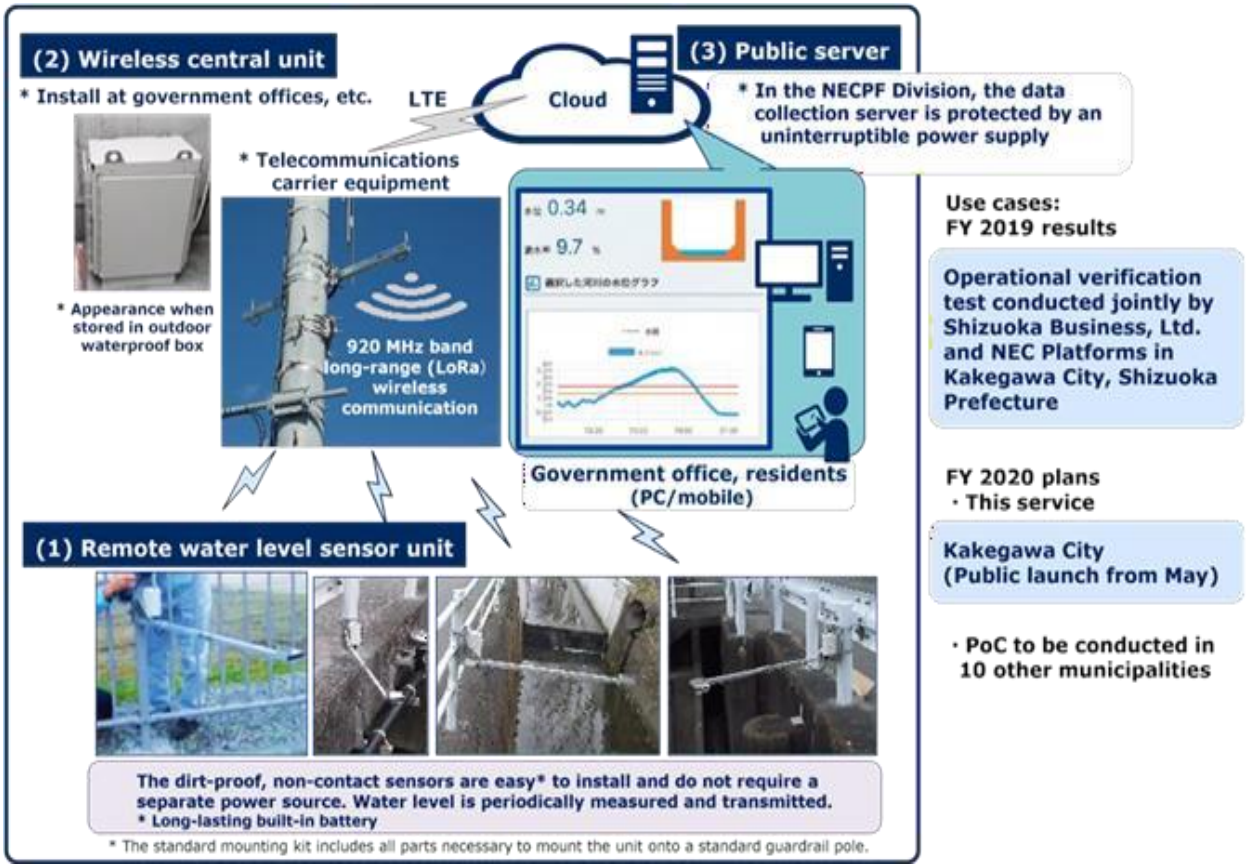
Water level measurements for each river are collected using LPWA* technology, currently attracting attention for use in IoT devices.

・Wide Area: Capable of communication within a 8.5 km (prospect) radius (bench test completed)

・Low Power: Coverage flexibly adapted to the locality is provided via low power radio waves (requiring no radio license)

・Scalability: Data is multiplexed on a single radio wave. Water meters and other sensors can be added on in the future and used simultaneously with existing sensors.

Collected data can be visualized on the Internet and used to support river management and local disaster management efforts.



Among the eight risks of climate change indicated by the United Nations' Intergovernmental Panel on Climate Change (IPCC), the risks that can be mitigated by this solution are the following.

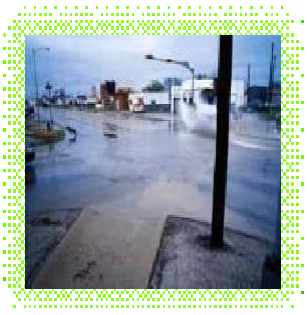
(The numbering of the items below corresponds to the numbering of "the eight risks of climate change" on the following page.)

1.Damage caused by flooding in urban areas:

Visualization of river water levels can support efforts in urban river management and local disaster management, and potentially help to mitigate and avoid damage caused by flooding in urban areas.

2.Breakdown of infrastructure and other societal functions due to extreme weather events:

Sensors can be attached to existing drainage facilities to visualize facility operation. Early detection of overload or stoppage of operations at facilities can enable rapid response to any failures in infrastructure, including facilities and roads. This can potentially help to mitigate and avoid breakdown of infrastructure and other societal functions due to extreme weather events.




1.2 PURPOSE:

Without water, no life could exist, and many essential and nonessential human activities wouldn't be possible without the use of healthy watersheds.

These same activities can impact watersheds, in ways both large and small.
Watersheds often span political and cultural boundaries; while neighbors separated by city, state or national borders may not live under the same legal and cultural guidelines as one another, both could be citizens of the same watershed.

By this measure, ensuring the health of a watershed — or the lakes, streams and rivers within — is as much a responsibility to your fellow human as it is to your local, state or federal regulating agency.

For this same reason, water quality regulations are increasingly focused on the watershed level rather than established by political boundaries.

Streams and rivers offer an above ground glimpse at the health and hydrology of a watershed, and function as a vital resource for human activity, as well as habitat for a host of non-human animals and plants.

In the U.S. alone, there are over 3.5 million miles of streams and rivers flowing through many different landscapes.

Despite this widespread reliance on waterways, the U.S. Environmental Protection Agency has found that over half of streams and rivers in the U.S. are in poor biological condition.

If a stream or river may be impacted by your project, it is vital to establish a proper monitoring system to ensure that the waterway's hydrology and water quality are affected as little as possible, and so that any impact can be mitigated if it is detected.

2. LITERATURE SURVEY:

As real time water quality monitoring is emerging all over the world. From drinking water to industrial waste water. In this general water quality parameters are total Organic carbon, Residual Chlorine, Conductivity, pH, Turbidity.

Total three subsystems are used:

• Data Transmission subsystem.

• Data collection Subsystem.

• Data Management Subsystem.

Various types of parameters are measured with sensors by placing them into different solutions of water. Data generated is compared with standard values in cloud and if exceeds then message sent from cloud to the users mobile. The given paper presents a detailed information of recent works carried out in smart water quality monitoring. Also, a power efficient, simpler solution for in pipe water quality monitoring based on Internet of Things technology is presented. The system developed in this paper is generally used for testing water samples and the data uploaded over the Internet are analyzed. The paper presents a detailed survey on the different techniques implemented in existing smart water quality monitoring systems. Also, a low cost, less complex water quality monitoring system is proposed.

[1] In this paper we got the idea about how previously water quality is monitored. As

1. Autonomous water quality monitoring using GSM.
2. Using Image Processing technology for water quality monitoring system.
3. Using Zigbee protocol.

The proposed system of this paper describes conditions of water quality through various sensors like pH, Water level, Turbidity, Conductivity using WSN through microcontroller and Wi-Fi [5]. From this paper we got the details of each sensor pH, Temperature, Turbidity, Conductivity, Water level etc. How these sensors are working and how they will get interfaced with Arduino controller. how the data generated by sensors will get transferred to the cloud in our proposed system [6]. We studied that the high use of fertilizers and other chemical sectors such as mining and construction have reduced overall quality of water. This paper gives study about Fiji Islands water quality which requires frequent data collecting network for water quality monitoring using IoT and RS (Remote Sensing). The comparative study is provided for different parameters such as pH, Turbidity, Conductivity, Temperature etc. [7]. In this paper, methodologies results are as, when the sensor board is switched on, the sensors are stumble on individual water parameter information. Here represented and we studied about statistics of water stage pH, Turbidity,

Temperature etc. are displayed on the dashboard of system. [9] This paper also proposes a sensor-based water quality monitoring system measuring physical and chemical parameters of water. This paper is beneficial for the development of water quality measuring devices, for measuring and analysis of water used for various living things ex. Human beings, animals as well as marine fishes and plants. It focuses on checking odour, Water level, Turbidity and temperature and verified on a daily basis. Here also Data transmission subsystem include wireless communication device with built in security features that transmits data from controller to data storage.

J.Navarajan et al.[1]: This research paper focuses on Detection on water pollution and water management using smart sensors Iot To ensure the safe supply of drinking water the quality should be monitored in real time for that purpose new approach IOT (Internet of Things) based water quality monitoring has been proposed. This system consists some sensors. Which measure the water quality parameter such as pH, turbidity, conductivity, dissolved oxygen, temperature. The measured values from the sensors are processed by microcontroller and these processed values are transmitted remotely to the core controller that is raspberry pi using Zigbee protocol. Based on a study of existing water quality monitoring system and scenario of water we can say that proposed system is more suitable to monitor water quality parameters in real time. Based on a study of existing water quality monitoring system and scenario of water we can say that proposed system is more suitable to monitor water quality parameters in real time.

Natasa Markovic et al. [2]: this research paper focuses on Sensor Web for River Water Pollution Monitoring and Alert System Sensor Web has provided infrastructure for collecting and processing data from distributed and heterogeneous sensors. This set of technologies has found various implementations, especially in the area of environmental monitoring. The Sensor Web architecture for crisis management, described in this paper, provides active monitoring of measuring parameters and timely responses in cases of environmental disasters. The River Water Management and Alert System built on this architecture enable access, control and management of river water pollution.

K. A. Unnikrishna Menon et al,[3]: This research paper focuses on Wireless Sensor Network for River Water Quality Monitoring in India This paper introduces a river water quality monitoring system based on wireless sensor network which helps in continuous and remote monitoring of the water quality data in India. The wireless sensor node in the system is designed for monitoring the pH of water, which is one of the main parameters that affect the quality of water. Wireless sensor Network which aids in River Water Quality Monitoring. This paper also proposes a novel technique for the design of a water quality sensor node which can be used for monitoring the pH of water.

1.Aswinkumar et al.[4]: This research paper focuses on Detection on water pollution and water management using smart sensors iotTo ensure the safe supply of drinking water the quality should be monitored in real time for that purpose new approach IOT (Internet of Things) based water quality monitoring has been proposed.

This system consists some sensors. Which measure the water quality parameter such as pH, turbidity, conductivity, dissolved oxygen, temperature.

The measured values from the sensors are processed by microcontroller and these processed values are transmitted remotely to the core controller that is raspberry pi using Zigbee protocol.

Based on a study of existing water quality monitoring system and scenario of water we can say that proposed system is more suitable to monitor water quality parameters in real time. Based on a study of existing water quality monitoring system and scenario of water we can say that proposed system is more suitable to monitor water quality parameters in real time Leonid Stoimenovet al.

[5]: this research paper focuses on Sensor Web for River Water Pollution Monitoring and Alert SystemSensor Web has provided infrastructure for collecting and processing data from distributed and heterogeneous sensors.

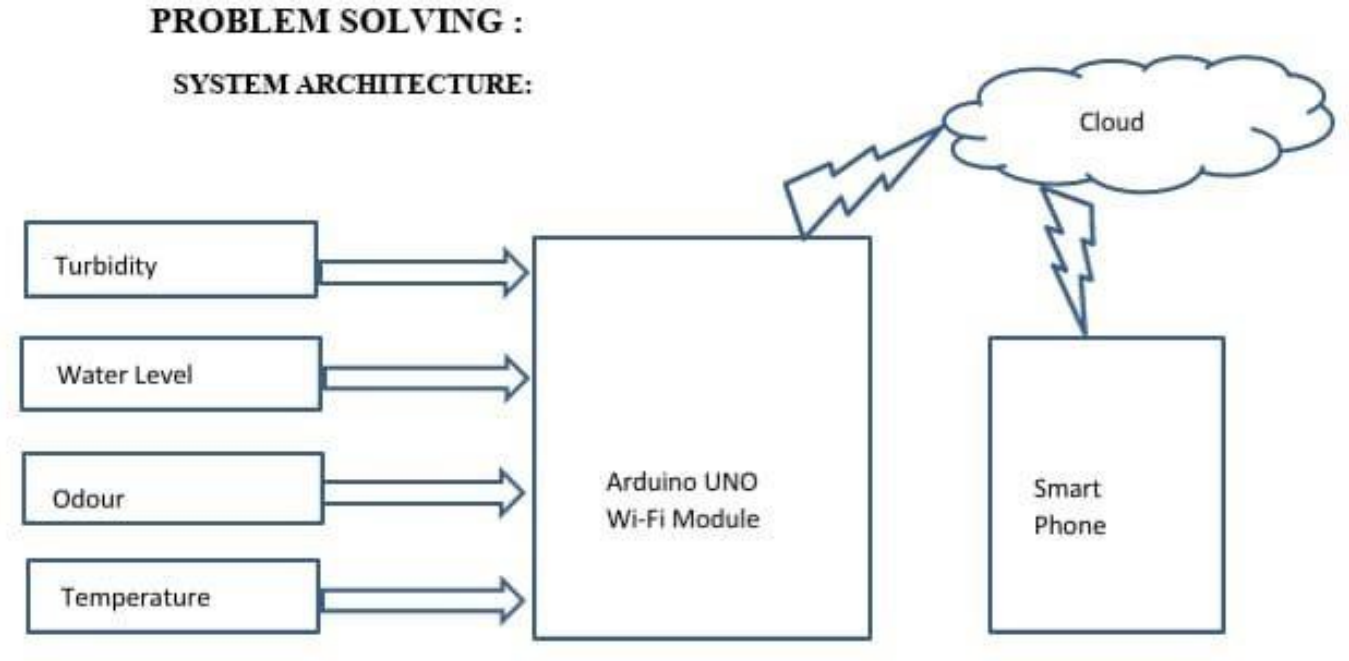
This set of technologies has found various implementations, especially in the area of environmental monitoring. The Sensor Web architecture for crisis management, described in this paper, provides active monitoring of measuring parameters and timely responses in cases of environmental disasters. The River Water Management and Alert System built on this architecture enable access, control and management of river water pollution.

Maneesha V. Ramehet al,[6]: This research paper focuses on Wireless Sensor Network for River Water Quality Monitoring in India This paper introduces a river water quality monitoring system based on wireless sensor network which helps in continuous and remote monitoring of the water quality data in India.

The wireless sensor node in the system is designed for monitoring the pH of water, which is one of the main parameters that affect the quality of water.

Wireless sensor Network which aids in River Water Quality Monitoring. This paper also proposes a novel technique for the design of a water quality sensor node which can be used for monitoring the pH of water.

2.1 Existing Problem:



DECISION TREE (ALGORITHM):

Decision Trees are considered for representing classifiers. A decision tree is a classifier expressed as a recursive partition of the instance space. The decision tree consists of set nodes that form a rooted tree, it is a directed tree with a node called root that has no incoming edges. All other nodes have only one incoming edge.

A node with outgoing edges is called an internal or test node. Decision tree generates the rule for the classification of the generated data set. The decision tree generally represents the flow chart like a tree structure that classifies instances by sorting them based on the feature (attribute) value [12].

2.2 References:

[1] K. S. Adul-Manu, C. Tapparello, W. Heintzelman, F. A. Katsriku, and J.-D. Abdula, "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.

[7] S. Thombre, R. U. Islam, K. Andersson, and M. S. Hossain, "Performance Analysis of an IP based Protocol Stack for WSNs", in Proceedings of the 2016 IEEE Conference on Computer Communications Workshops (INFOCOM WKSHPS), 2016, pp. 691–696.

[8] M. Z. Abedin, A. S. Chowdhury, M. S. Hossain, K. Andersson, and R. Karim, "An Interoperable IP based WSN for Smart Irrigation Systems", presented at the 14th Annual IEEE Consumer Communications & Networking Conference, Las Vegas, 8-11 January 2017, 2017.

[9] M. Z. Abedin, S. Paul, S. Akhter, K. N. E. A. Siddique, M. S. Hossain, and K. Andersson, "Selection of Energy Efficient Routing Protocol for Irrigation Enabled by Wireless Sensor Networks", in Proceedings of 2017 IEEE 42nd Conference on Local Computer Networks Workshops, 2017, pp. 75–81.

[10] R. Ul Islam, K. Andersson, and M. S. Hossain, "Heterogeneous Wireless Sensor Networks Using CoAP and SMS to Predict Natural Disasters", in Proceedings of the 2017 IEEE

Conference on Computer Communications Workshops (INFOCOM WKSHPS) : The 8th IEEE INFOCOM International Workshop on Mobility Management in the Networks of the Future World (MobiWorld'17), 2017, pp. 30–35. [11] K. N. E. A. Siddique, F. F. Khan, K. Andersson, and M. S. Hossain, "Optimal Dynamic Routing Protocols for Agro-Sensor Communication in MANETs", in Proceedings of the 14th Annual IEEE Consumer Communications & Networking Conference, Las Vegas, 8-11 January 2017.

[11] K. N. E. A. Siddique, F. F. Khan, K. Andersson, and M. S. Hossain, "Optimal Dynamic Routing Protocols for Agro-Sensor Communication in MANETs", in Proceedings of the 14th Annual IEEE Consumer Communications & Networking Conference, Las Vegas, 8-11 January 2017.

[12] M. E. Alam, M. S. Kaiser, M. S. Hossain, and K. Andersson, "An IoT-Belief Rule Base Smart System to Assess Autism", in Proceedings of the 4th International Conference on Electrical Engineering and Information & Communication Technology (iCEEiCT 2018), 2018, pp. 671–675.

[13] P. W. Rundel, E. A. Graham, M. F. Allen, J. C. Fisher, and T. C. Harmon, "Environmental sensor networks in ecological research," New Phytologist, vol. 182, pp. 589-607, 2009.

[14] N. Chilamkurti, S. Ze dally, A. Vasilakos, and V. Sharma, "Cross-layer support for energy efficient routing in wireless sensor networks," Journal of Sensors, vol. 2009, 2009.

[15] H. R. Maier and G. C. Dandy, "The use of artificial neural networks for the prediction of water quality parameters," Water resources Research, vol. 32, pp. 1013-1022, 1996.

[16] N. Vijayakumar and R. Ramya, "The real time monitoring of water quality in IoT environment," in 2015 International Conference on Innovations in Information, Embedded and Communication Systems (ICIIECS), 2015, pp. 1-5.

[17] T. White, Hadoop: The definitive guide: " O'Reilly Media, Inc.", 2012.

[18] A. K. Jain, J. Mao, and K. Mohiuddin, "Artificial neural networks: A tutorial," Computer, pp. 31-44, 1996.

[19] H. R. Maier and G. C. Dandy, "The use of artificial neural networks for the prediction of water quality parameters," Water resources Research, vol. 32, pp. 1013-1022, 1996.

[20] M. S. Hossain, S. Rahaman, R. Mustafa, and K. Andersson, "A belief rule-based expert system to assess suspicion of acute coronary syndrome (ACS) under uncertainty", Soft Computing - A Fusion of Foundations, Methodologies and Applications, vol. 22, no. 22, pp. 7571–7586, 2018.

[21] T. Mahmud, K. N. Rahman, and M. S. Hossain, "Evaluation of Job Offers Using Evidential Reasoning", Global Journal of Computer Science and Technology, Vol. 13, No. 6, 2013, pp. 41-50.

[22] M. S. Hossain, K. Andersson, and S. Naznin, "A Belief Rule Based Expert System to Diagnose Measles under Uncertainty", in Proceedings of the 2015 International Conference on Health Informatics and Medical Systems (HIMS'15), 2015, pp. 17–23.

[23] M.S. Hossain, PO., Zander, S. Kamal, and L. Chowdhury, "Belief Rule Based Expert Systems to Evaluate E-Government", Expert Systems, The Journal of Knowledge Engineering, Vol. 32, No.5, 2015, Jhon Wiley & Sons Ltd.

[24] M. S. Hossain, F. Ahmed, F. Tuj-Johora, and K. Andersson, "A Belief Rule Based Expert System to Assess Tuberculosis under Uncertainty", Journal of medical systems, vol. 41, no. 3, 2017.

[25] M. S. Hossain, S. Rahaman, A.-L. Kor, K. Andersson, and C. Pattison, "A Belief Rule Based Expert System for Datacenter PUE Prediction under Uncertainty", IEEE Transactions on Sustainable Computing, vol. 2, no. 2, pp. 140–153, 2017.

[26] S. Geetha, S. Gouthami, "Internet of things enabled real time water quality monitoring system.", DOI 10.1186/s40713-017-0005-y (2017).

[27] Jianhua D, Guoyin W, Huyong Y, Ji X, Xuerui Z "A survey of smart water quality monitoring system.", Environ SciPollut Res 22(7):4894906 (2015).

[28] JAYTI BHATT, JIGNESH PATOLIYA "IOT BASED WATER QUALITY MONITORING SYSTEM.", ISSN:2347-6982(2016).

[29] Pradeep Kumar M, Monisha J, Pravenisha R "The Real Time Monitoring of Water Quality in IoT Environment.", ISSN:2347-6710, DOI:10.15680/IJIRSET.2016.0503246.

[30] [Aaina Venkateshswaran, Harsha Menda, Prof Priti Badar "An IoT Based System for Water Quality Monitoring.", ISSN:2320-9798, DOI:10.15680/IJIRCCE.2017.05004266.

2.3 Problem Statement Definition:

Water is a finite resource that is necessary for agriculture, industry and the-survival of all living things on the planet, including humans.

Many people are unaware of the need of drinking adequate amounts of water on a daily basis.

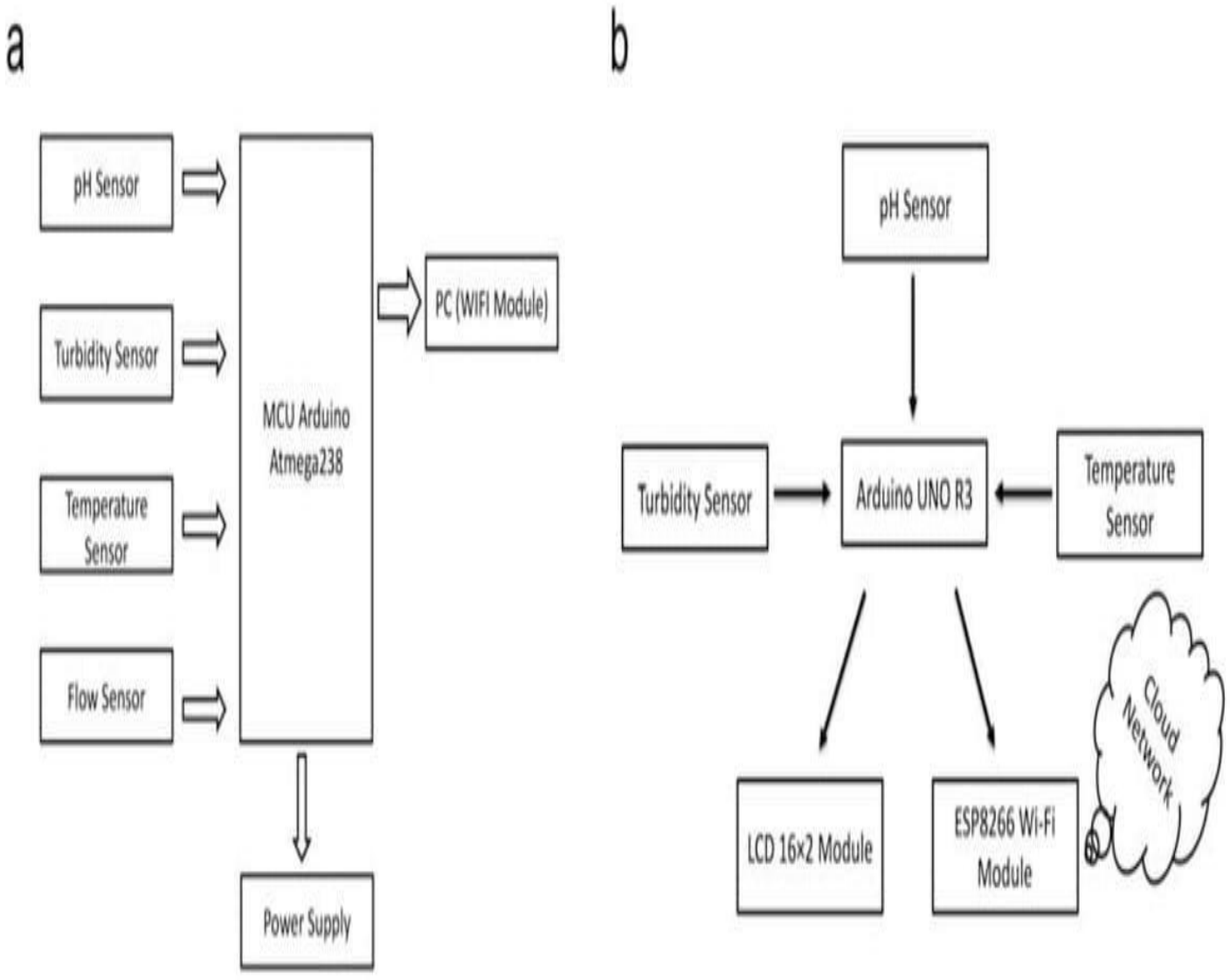
Many unregulated methods waste more water.

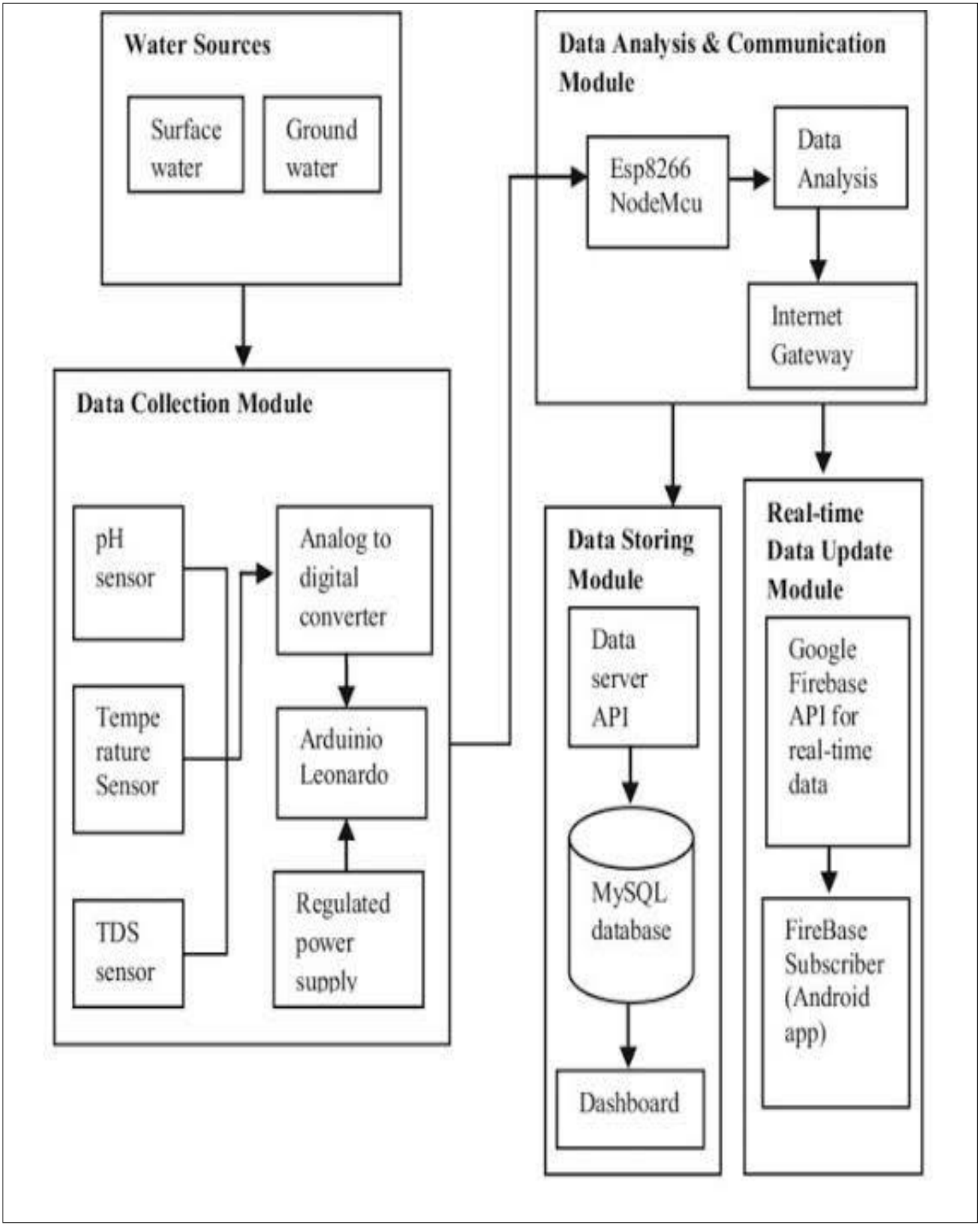
Poor water allocation, inefficient consumption, lack of competent and integrated water management are all factors that contribute to this problem.

Therefore, efficient use and water monitoring are potential constraint for home or office water management system.

3. IDEATION AND PROPOSED SOLUTION:

3.1 Empathy Map Canvas:




Water Sources
Surface water
Ground water
Data Analysis & Communication Module
Esp8266 NodeMcu
Data Analysis
Internet Gateway
Data Collection Module
pH sensor
Tempe rature Sensor
TDS sensor
Analog to digital converter
Arduinio Leonardo
Regulated power supply
Data Storing Module
Data server API
MySQL database
Dashboard
Real-time Data Update Module
Google Firebase API for real-time data
FireBase Subscriber (Android app)

3.2 Ideation and Brainstorming:

Arduino Mega Board:

Arduino is an open -source electronics prototyping platform based on flexible, easy-to-use hardware and software.

It's intended for artists, designers, hobbyists, and anyone interested in creating interactive objects or environments.

Or more simply, you load on some code and it can read sensors, perform actions based on inputs from buttons, control motors, and accept shields to further expand its capabilities.

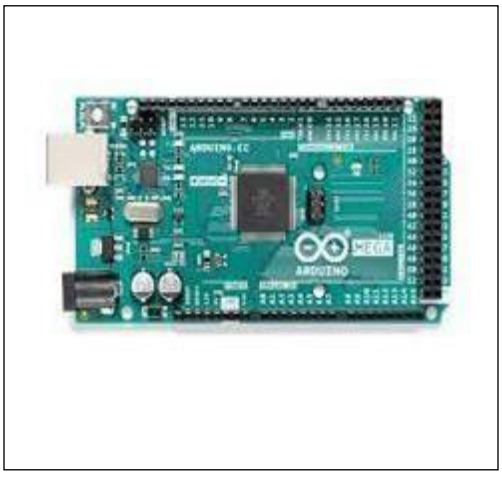
Really, you can do almost anything. All Arduino boards have one thing in common: they are programmed through the Arduino IDE.

This is the software that allows you to write and upload code. Beyond that, there can be a lot of differences.

The number of inputs and outputs (how many sensors, LEDs, and buttons you can use on a single board), speed, operating voltage, and form factor are just a few of the variables.

Some boards are designed to be embedded and have no programming interface (hardware) which you would need to buy separately.

Some can run directly from a 3.7V battery, others need at least 5V.

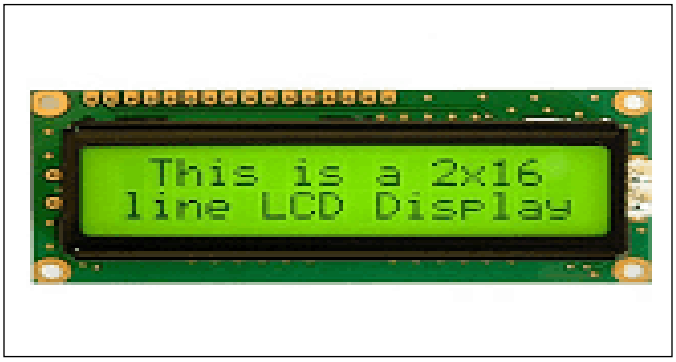


Liquid-crystal display (LCD):

It is a flat-panel display or other electronically modulated optical device that uses the light-modulating properties of liquid crystals.

Liquid crystals do not emit light directly, instead using a backlight or reflector to produce images in color or monochrome.

[1] LCDs are available to display arbitrary images (as in a general-purpose computer display) or fixed images with low information content, which can be displayed or hidden, such as preset words, digits, and seven- segment displays, as in a digital clock.



Temperature and PH sensor:

To measure the temperature of a water tank and log it via the Arduino. The idea is to maintain the temperature of the water at 25-30C at all times.

I've noticed that most applications have used a sensor such as DS18S20 or TMP35/TMP36/TMP37.

But since my application requires to measure the temperature in water, I think a more suitable sensor should have a waterproof probe (or external probe).

The usual way is to contain the water inside a tank / container which can transmit heat – usually metal.

To the outside of this is then bonded the temperature sensor – be that a simple bi- metallic strip thermostat, or a more complex temperature sensing transducer.

Of course, this requires a metal tank, and that will radiate heat, which will be wasteful.

Ideally you would want some form of waterproof probe. You haven't mentioned the amount of water you're dealing with – how big is the tank? How deep especially.

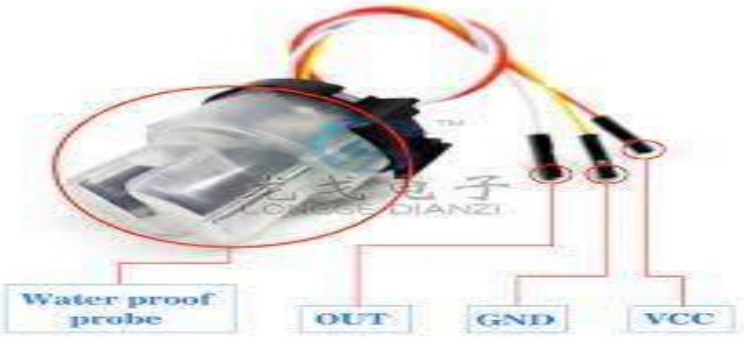
There are thermocouples available in a rigid probe form – quite how waterproof these are I'm not sure, but these are never very long, so you won't be able to get it more than 6 inches or so into the water before you risk complete submersion.

The Turbidity Sensor:

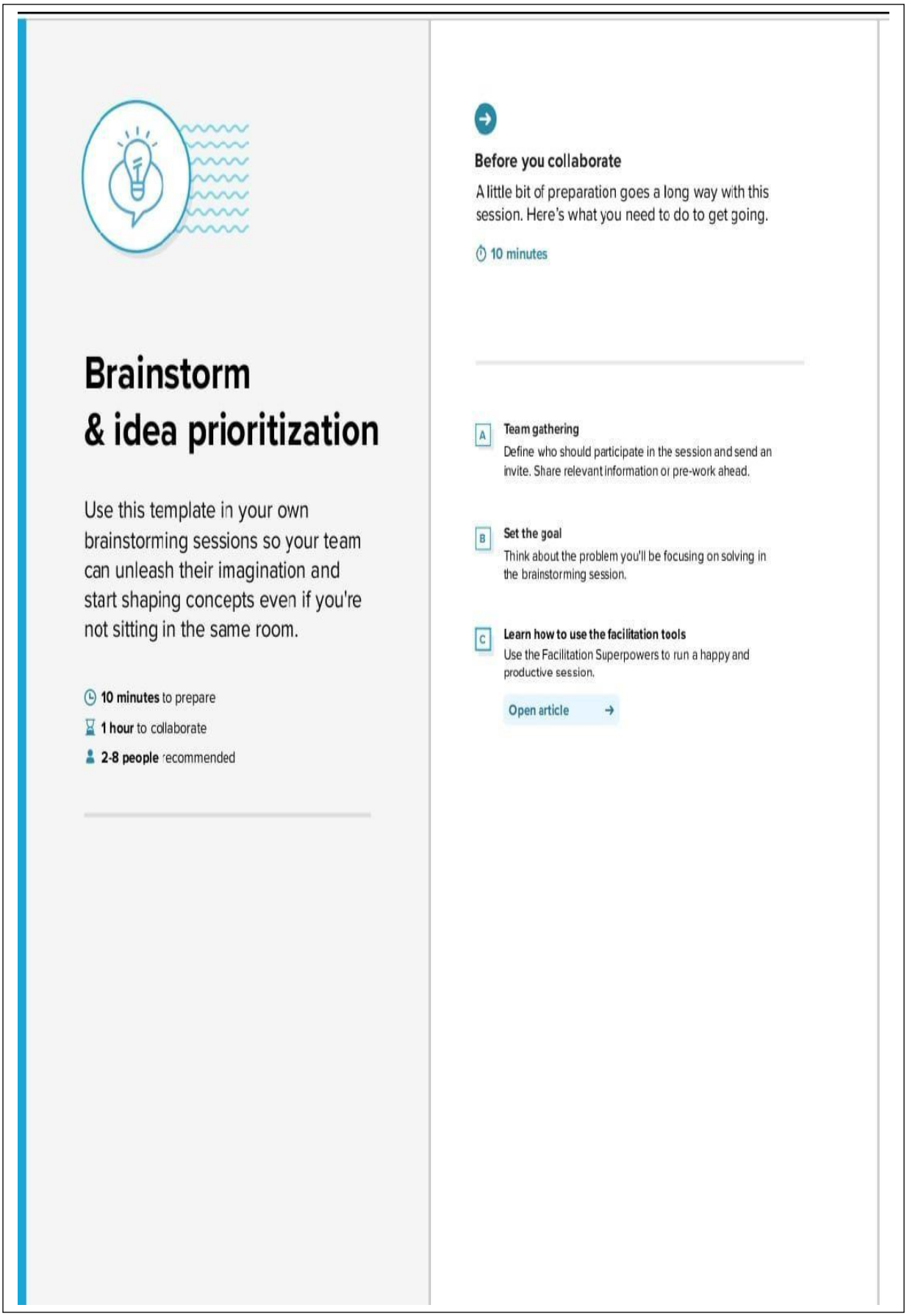
Turbidity is an indicator often used to find the amount of suspended sediment in water.

By cumbersome mechanical sampling, it is possible to measure the concentration of suspended solids (in mg/ l) in water, but turbidity is increasingly used instead, as it is easy to use and cheaper too.

It is an ecologically important parameter as the various effects of suspended solids in aquatic ecosystems are due to their light scattering properties rather than their absolute mass.



Brainstroming:



1

Define your problem statement

What problem are you trying to solve? Frame your problem as a How Might We statement. This will be the focus of your brainstorm.

5 minutes

PROBLEM

How might we [your problem statement]?

Key rules of brainstorming

To run an smooth and productive session

- Stay in topic.
- Defer judgment.
- Go for volume.
- Encourage wild ideas.
- Listen to others.
- If possible, be visual.

2

Brainstorm

Write down any ideas that come to mind that address your problem statement.

10 minutes

TIP

You can select a sticky note and hit the pencil [switch to sketch] icon to start drawing!

Yogeshwaran . P

- Validating details about watercourse
- Notification for crisis alert
- Consolidating accurate description
- Inserting sensors to check various parameters of water
- Measuring the quality of water
- Cross checking the traditional indicators

Saravanakumar . M

- Developing progress in cleaning up of water
- Revealing the health composition of water
- Ensuring in meeting out environmental standards
- Monitoring the quality of water condition
- Obtaining the quantitive information about water
- Determination of human impacts on river sources

Logesh . P

- Measurements made on site and in direct contact
- Exposing the water to bacteria test to prevent serious health issues
- Including water flow meter to detect the water quality
- Frequent sampling and monitoring is provided
- Undergoing various microbiological analyses to predict changes

Ram kumar . M

- Purifying the water based on record of river
- Categorizing the water by its characteristics
- Assessing future water predictions by different management strategies
- Implementation of techniques for environmental scanning
- Appropriate actions must overcome the environmental issues

3

Group ideas

Take turns sharing your ideas while clustering similar or related notes as you go. In the last 10 minutes, give each cluster a sentence-like label. If a cluster is bigger than six sticky notes, try and see if you and break it up into smaller sub-groups.

20 minutes

TIP

Add customizable tags to sticky notes to make it easier to find, browse, organize, and categorize important ideas as themes within your mural.

Fundamentals

Validating details about watercourse

vInserting sensors to check various parameters of water

Obtaining the quantitive information about water

Verification

Categoring the water by its characteristics

Cross checking the traditional indicators

Monitoring the quality of water condition

Consolidating accurate description

Objectives

Developing progress in cleaning up of water

Revealing the health composition of water

Measuring the quality of water

Purifying the water based on record of river

Other informations

Exposing the water to bacteria test to prevent serious health issues

,Frequent sampling and monitoring is provided

Undergoing various microbiological analysis to predict changes

Including water flow to detect the water quality

Specific features

Determination of human impacts on river sources

Notification for crisis alert

Ensuring in meeting out environmental standards

Measurements made on site and in direct contact

4

Prioritize

Your team should all be on the same page about what's important moving forward. Place your ideas on this grid to determine which ideas are important and which are feasible.

20 minutes

3.3 Proposed Solution:

S.no	Parameter	Description
1.	Problem Statement (Problem to be solved)	IOT Based Real Time River Water Quality Monitoring and Control System
2.	Idea / Solution description	1.To monitor the quality of water using sensors like temperature, potentiometer(pH), turbidity, salinity and so on. 2.Collecting those data and storing it in cloud and perform analyse to check if the water is contaminated or not for drinking. 3.If the water is contaminated an alert is made to the user/ local authority through SMS or can be viewed through web application anytime.
3.	Novelty / Uniqueness	1.Based on the collected data prediction is made whether the water can be used for cultivation of specific crops and suitable for the aquatic animals.
4.	Social Impact / Customer Satisfaction	Algal growth, fertilizers, pesticides cause river pollution which can impact all living beings. Better monitoring and control measures can impact health and vegetation massively.
5.	Business Model (Revenue Model)	Service based product is developed to serve the local people to know the quality of water before consuming it or using it for any purpose. This prevents health issues or at most loss of living being.
6.	Scalability of the Solution	Developing the product as both web and mobile application it is portable, and data can be accessed from anywhere anytime. provide a real-time monitoring and a feasible solution for remote or distant places where water quality laboratory is not present.

3.4 Problem Solution Fit:

Water is a finite resource that is necessary for agriculture, industry and the- survival of all living things on the planet, including humans.

Many people are unaware of the need of drinking adequate amounts of water on a daily basis.

Many unregulated methods waste more water.

Poor water allocation, inefficient consumption, lack of competent and integrated water management are all factors that contribute to this problem.

Therefore, efficient use and water monitoring are potential constraint for home or office water management system.

PROPOSED SYSTEM:

The goals of concept implementation are as follows:

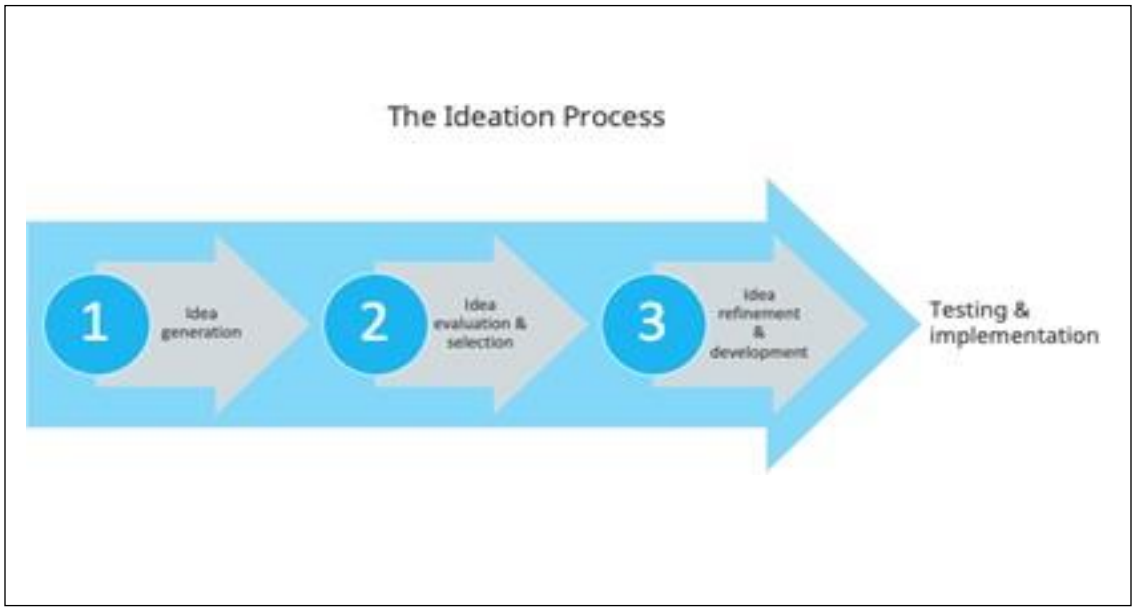
• Using accessible sensors at a distant location, monitor water parameters such as pH, dissolved oxygen, turbidity, conductivity, and so on.

• To collect data from various sensor nodes and transfer it through wireless channel to the base station.

•For quality control, to simulate and assess quality parameters.

• When the water quality observed does not meet the established standards, send an SMS to an authorized person on a regular basis so that relevant steps can be performed.

DIAGRAM:



4. REQUIREMENT ANALYSIS:

4.1 Functional Requirements:

Following are the functional requirements of the proposed solution.

s.no	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
1.	User Login	Confirmation through verified password
2.	View Water Details	View current water details in website View traditional water eligibility in website
3.	Logout	Logs out the user successfully

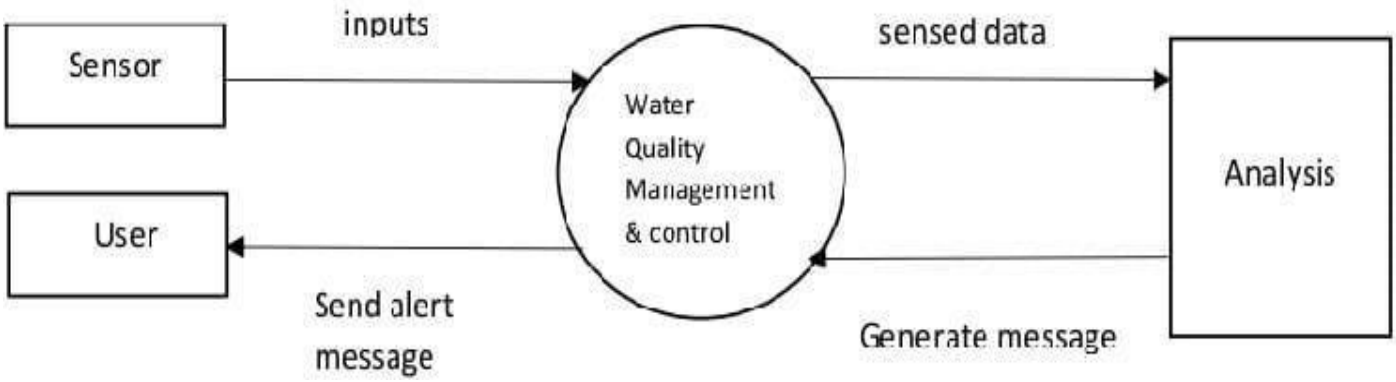
4.2 Non-functional Requirements:

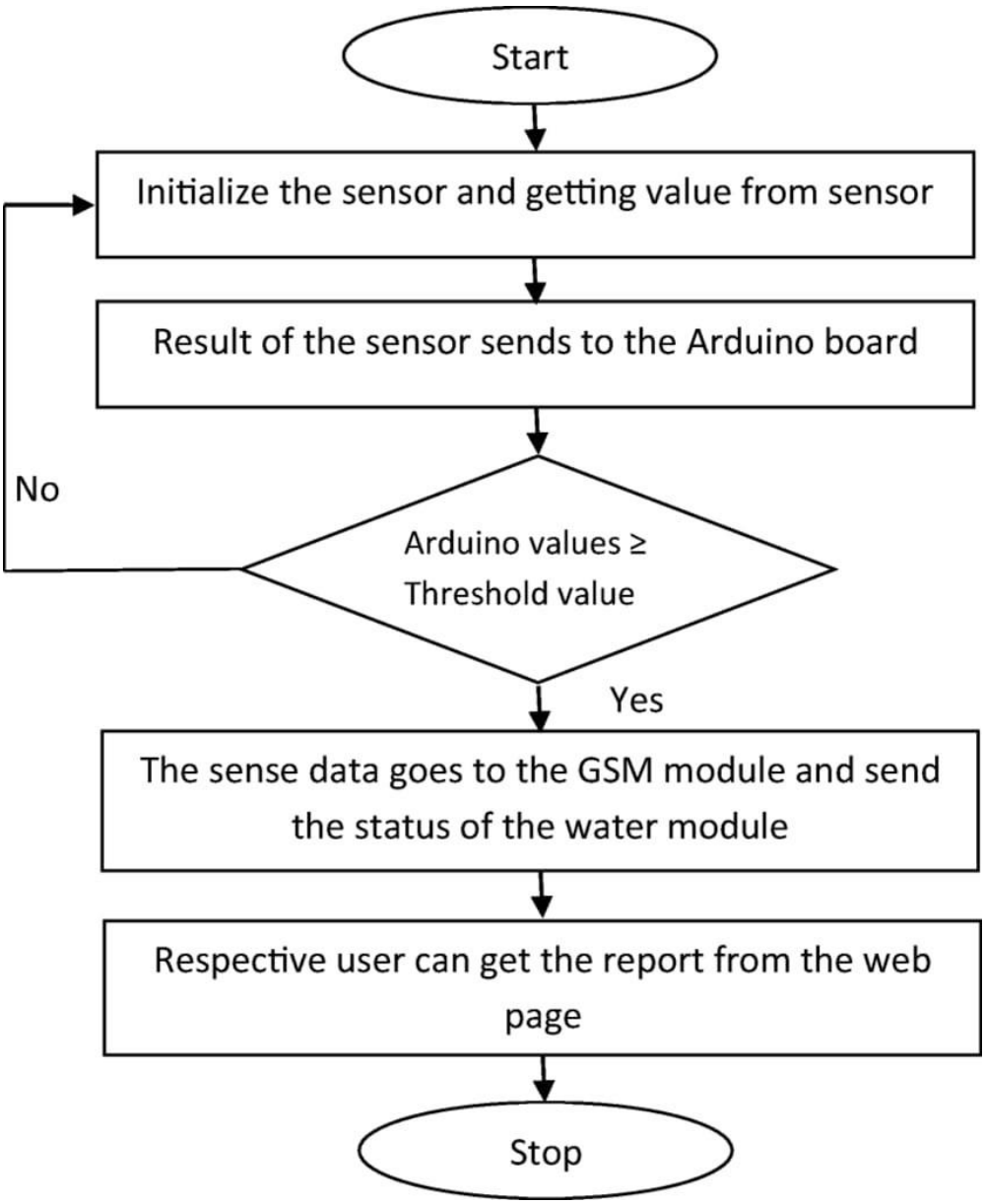
Following are the non-functional requirements of the proposed solution.

Fr.no	Non-functional Requirements	Description
NFR-1	Usability	Load time for user interface screens shall not be more than 2 seconds.
NFR-2	Security	User account is password protected Account creation done only after email verification
NFR-3	Reliability	Users can access their account 98% of the time without failure
NFR-4	Performance	Load time for user interface screens shall not be more than 2 seconds. Login info verified within 10 seconds.
NFR- 5	Availability	Load time for user interface screens shall not be more than 2 seconds. Login info verified within 10 seconds.
NFR-6	Scalability	System can handle about 1000 users at any given time

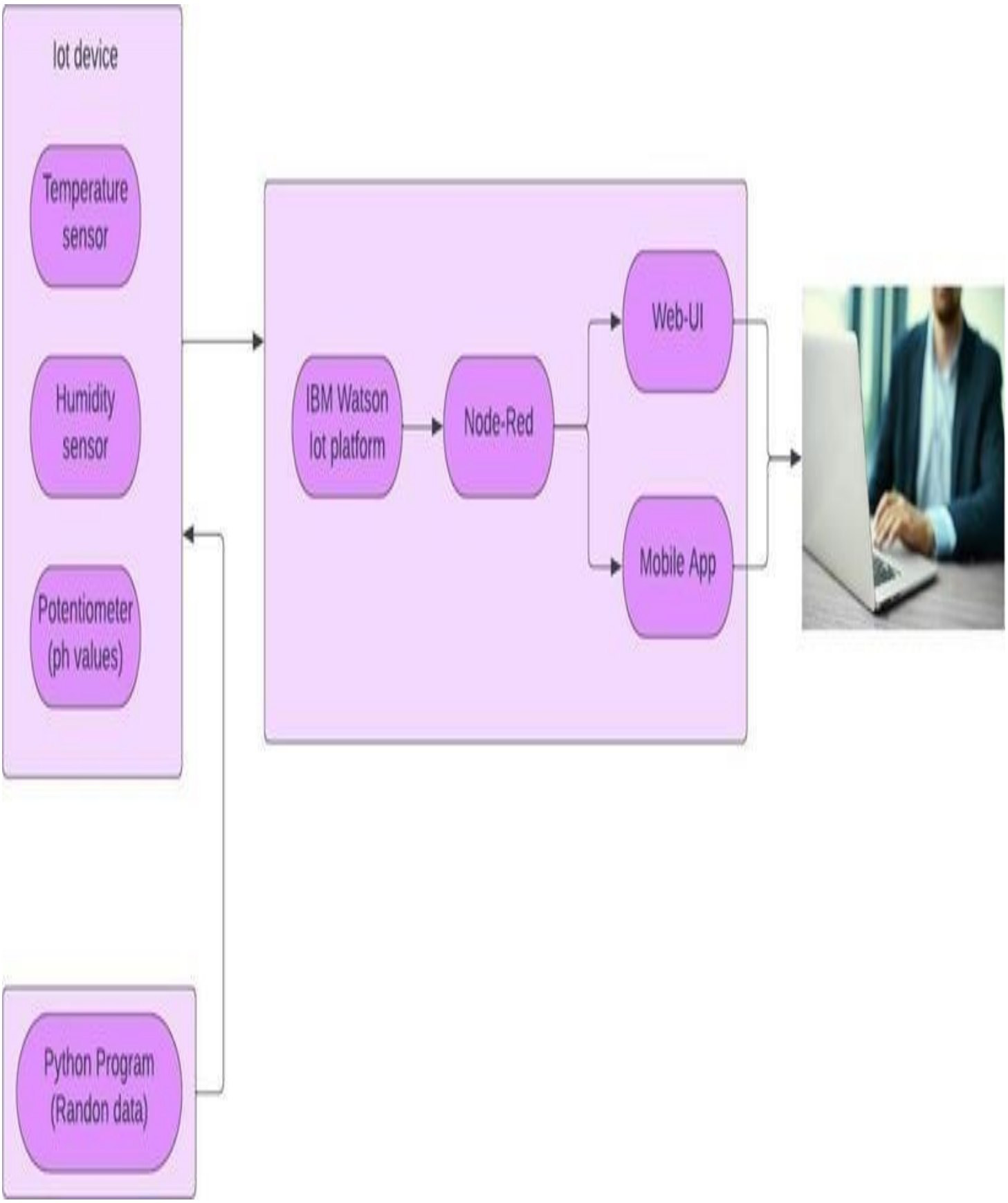
5. PROJECT DESIGN:

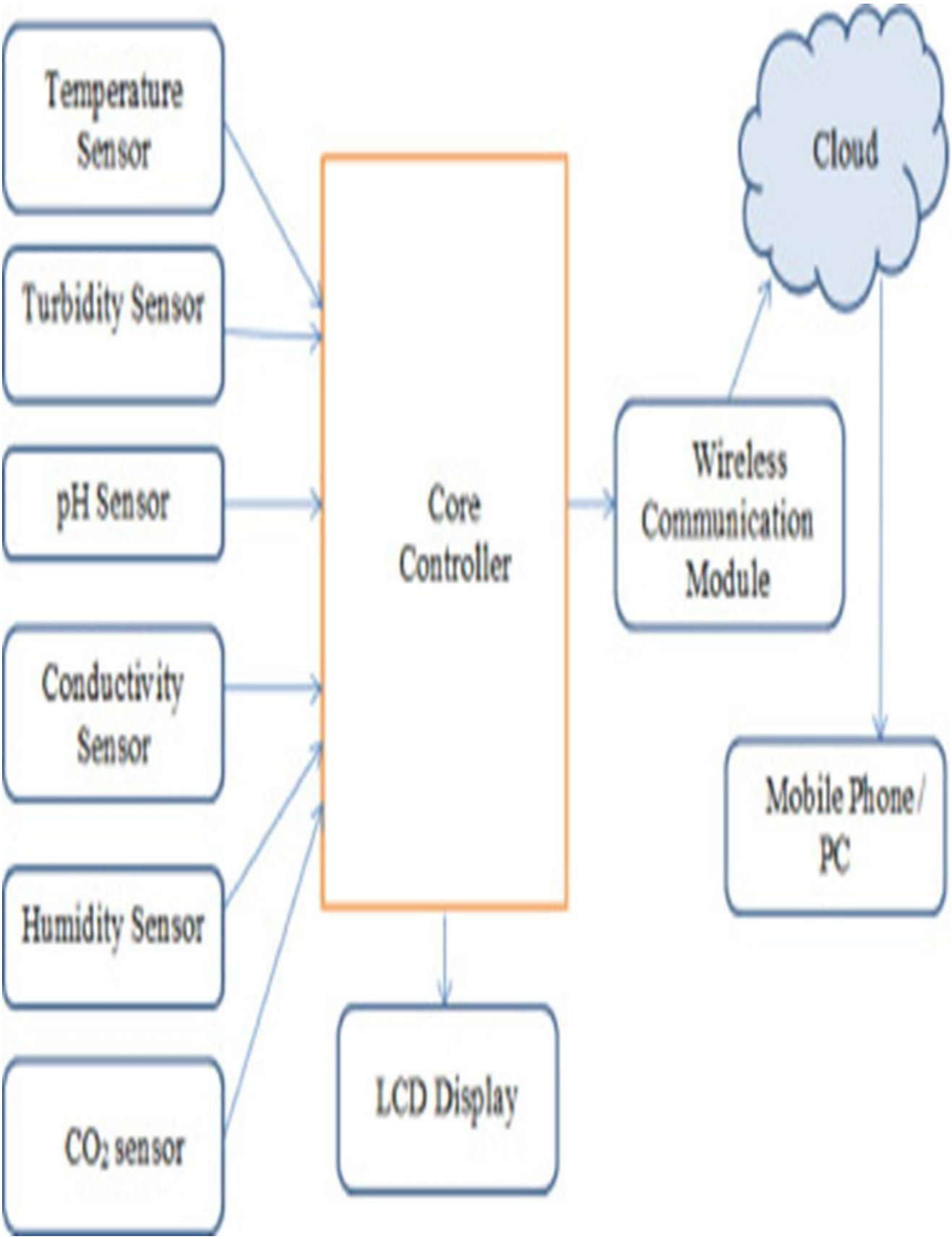
5.1 Data Flow Diagrams:





5.2 Solution and Technical Architecture:




Temperature Sensor
Turbidity Sensor
pH Sensor
Conductivity Sensor
Humidity Sensor
CO_2 sensor
Core Controller
LCD Display
Wireless Communication Module
Cloud
Mobile Phone / PC

5.3 User Stories:

User Type:

User (Mobile user)

Functional Requirement (Epic):

Check Notification

User Story Number:

USN-1

User Story / Task:

User can check the notification of the alert message.

Acceptance criteria:

User can check the notification

Priority:

High

Release:

Sprint-1

User Type:

User (Mobile user)

Functional Requirement (Epic):

Check water parameters

User Story Number:

USN-2

User Story / Task:

User can check the level of water parameters like temperature, humidity, PH level etc.

Acceptance criteria:

User can check the level of water parameters

Priority:

High

Release:

Sprint-1

6. PROJECT PLANNING & SCHEDULING:

6.1 Sprint Planning and Estimation

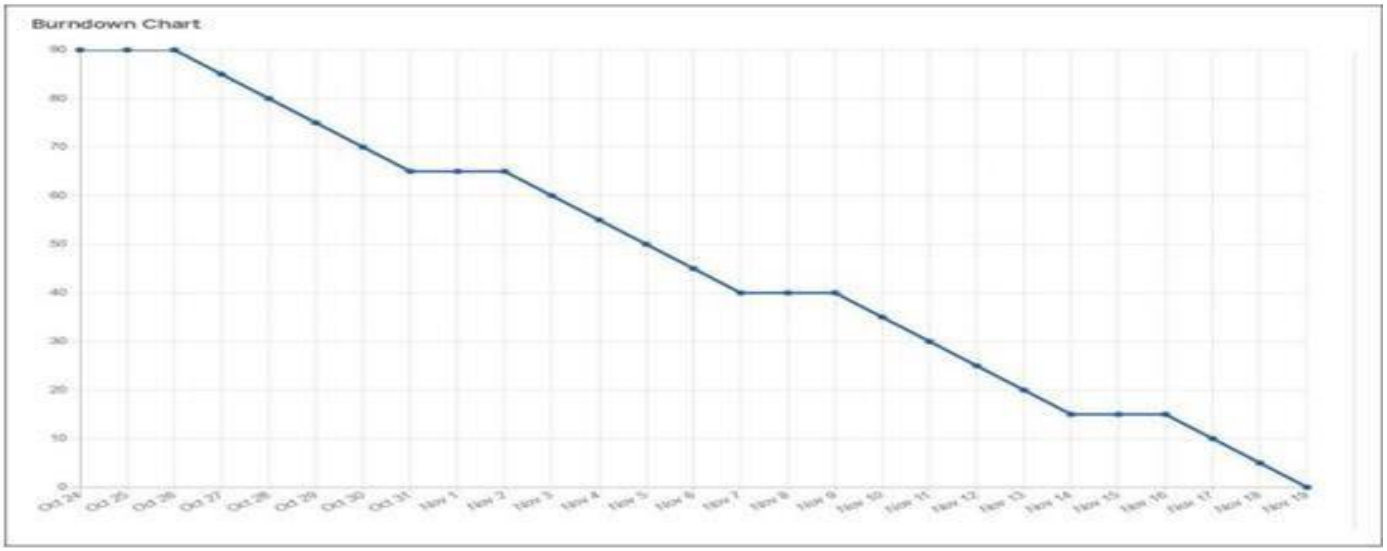
Velocity:

Imagine we have 10-day sprint duration, and the velocity of the team is 20 (points per sprint). Let's calculate the team's average velocity (AV) per iteration unit
(Story points per day)

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

Burndown Chart:

A burn down chart is a graphical representation of work left to do versus time.
It is often used in agile software development methodologies such as Scrum.
However, burn down charts can be applied to any project containing measurable progress over time.



6.2 Sprint Delivery Schedule:

S.no	Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points P	Priority	Team Members
1.	Sprint-1	Check Notification	USN-1	As a user, I can check the notification of the alert message.	20	High	Vibison.U, Santhosh kumar.S
2.	Sprint-2	Check water parameters	USN-2	As a user, I can check the level of water parameters like temperature, humidity, PH level etc.	20	High	Aruna. M, J.Sindhuja

Project Tracker, Velocity & Burndown Chart:

S.no	sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date (Actual)
1.	Sprint-1	20	6days	24 Oct 2022	29 Oct 2022	20	29 Oct 2022
2.	Sprint-2	20	6days	31 Oct 2022	05 Nov 2022	20	05 Nov 2022

Velocity:

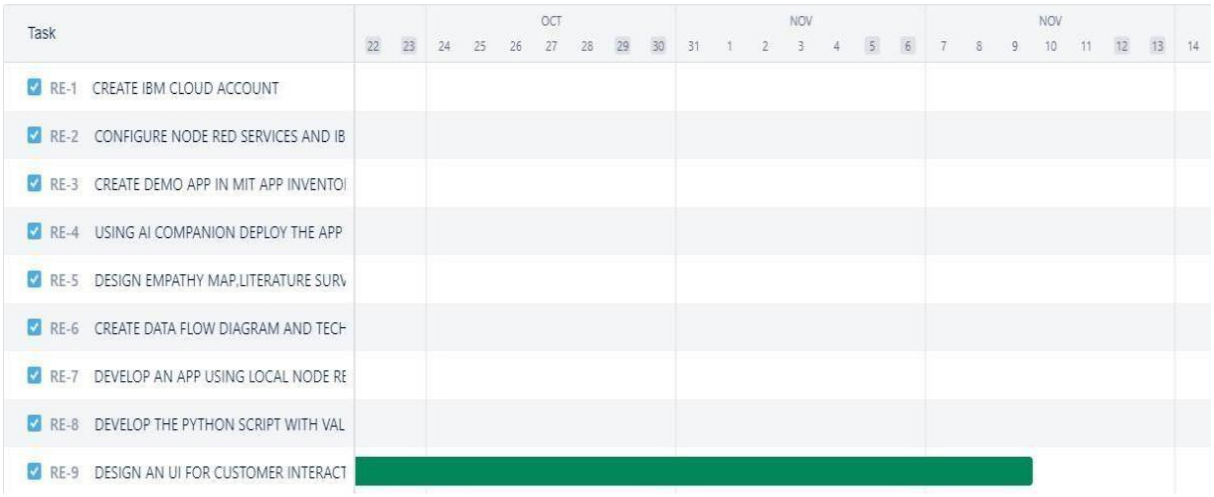
Sprint 1: 1 user story x 20 story points = 20

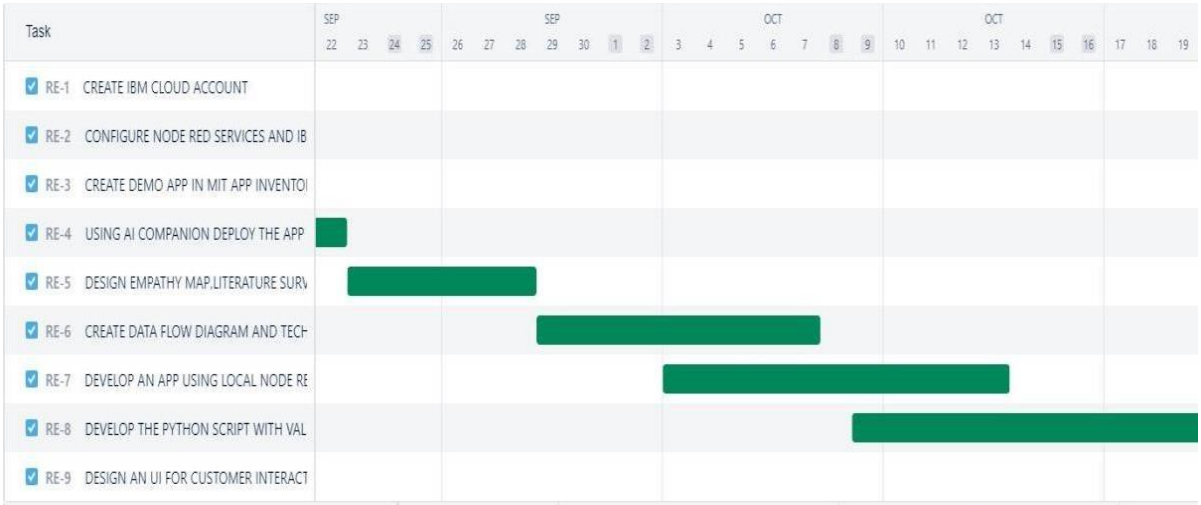
Sprint 2: 1 user story x 20 story points = 20

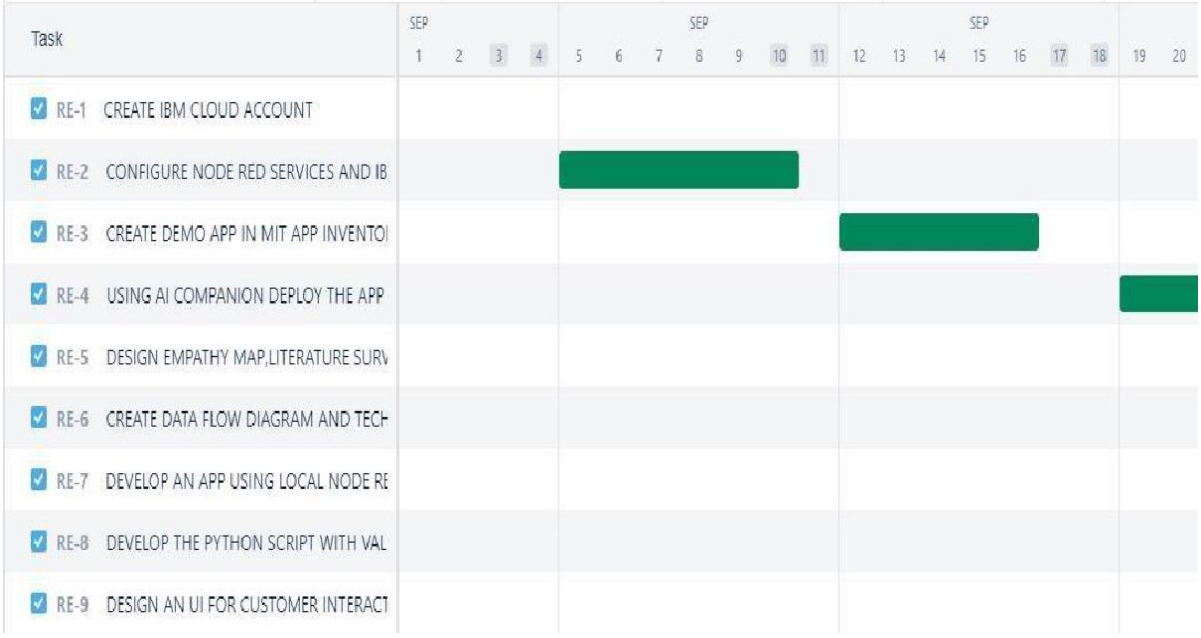
Total = 40

Average Sprint Velocity = 40 / 2 = 20

6.3 Reports from JIRA:



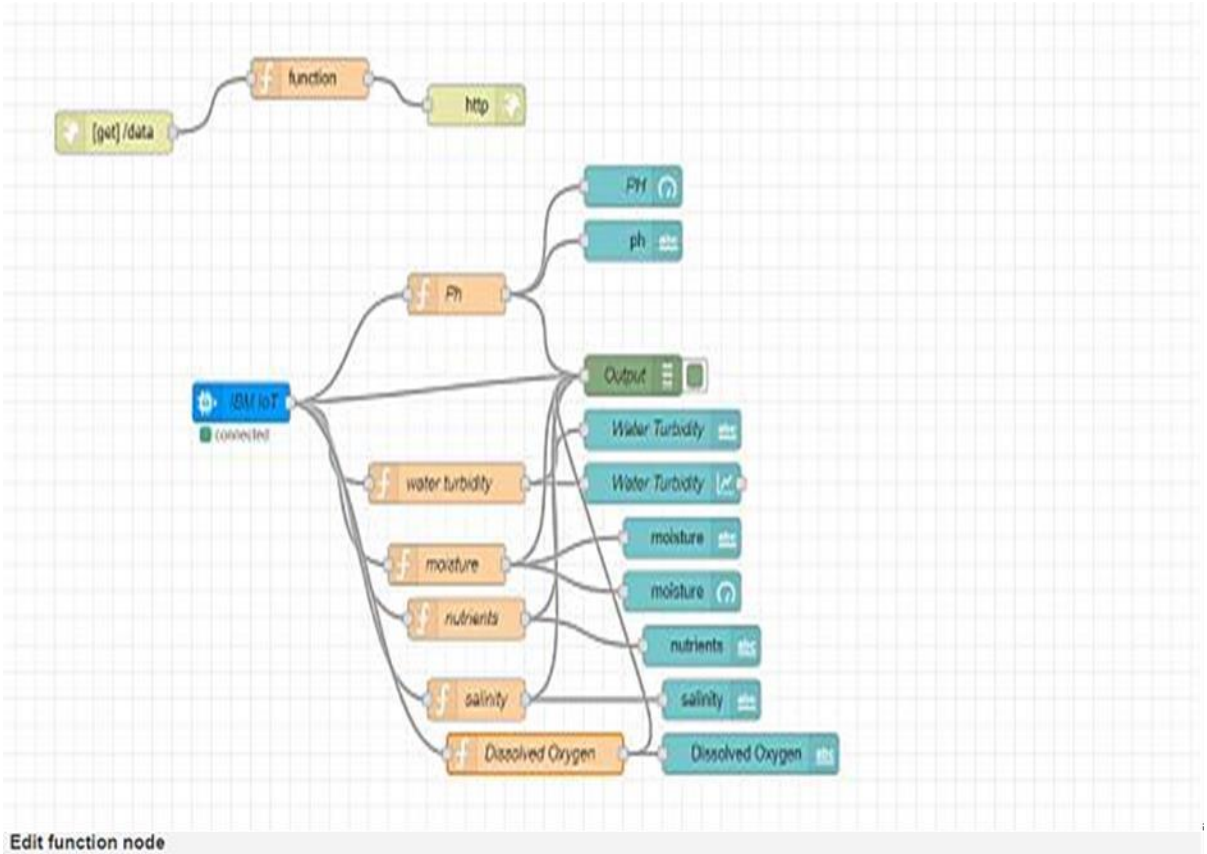


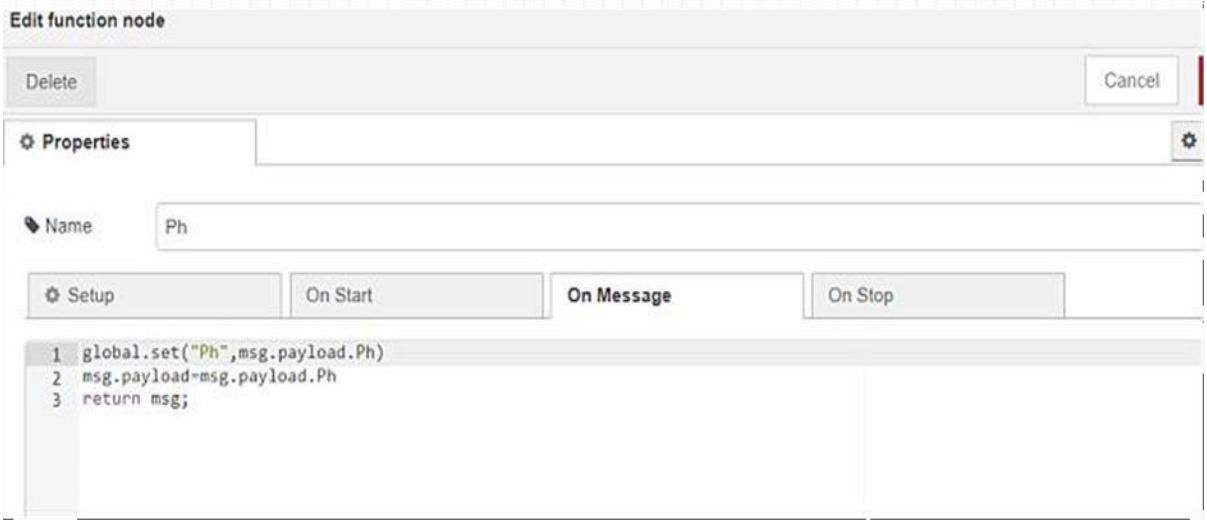


7. CODING & SOLUTIONING (Explain the features added in the project along with code):

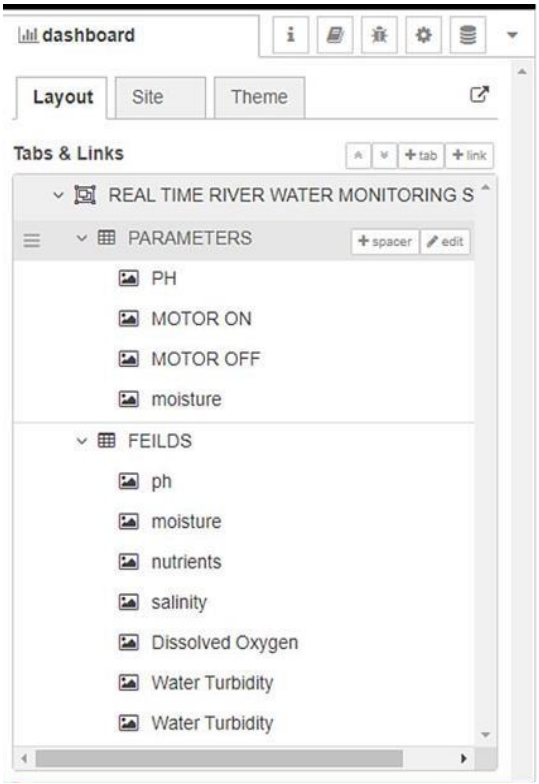
7.1 Feature1 & 2:

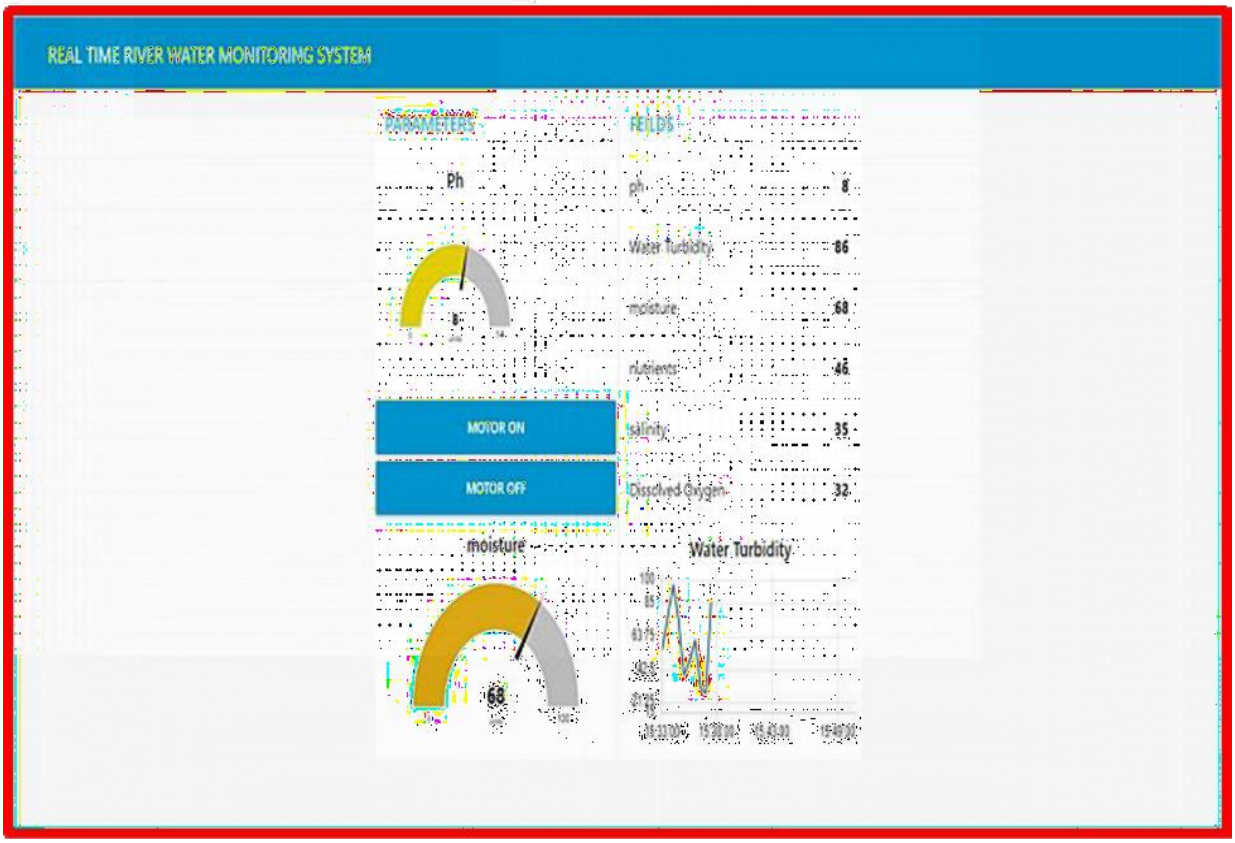
NODE RED SERVICE ASSOCIATED WITH IBM CLOUD:



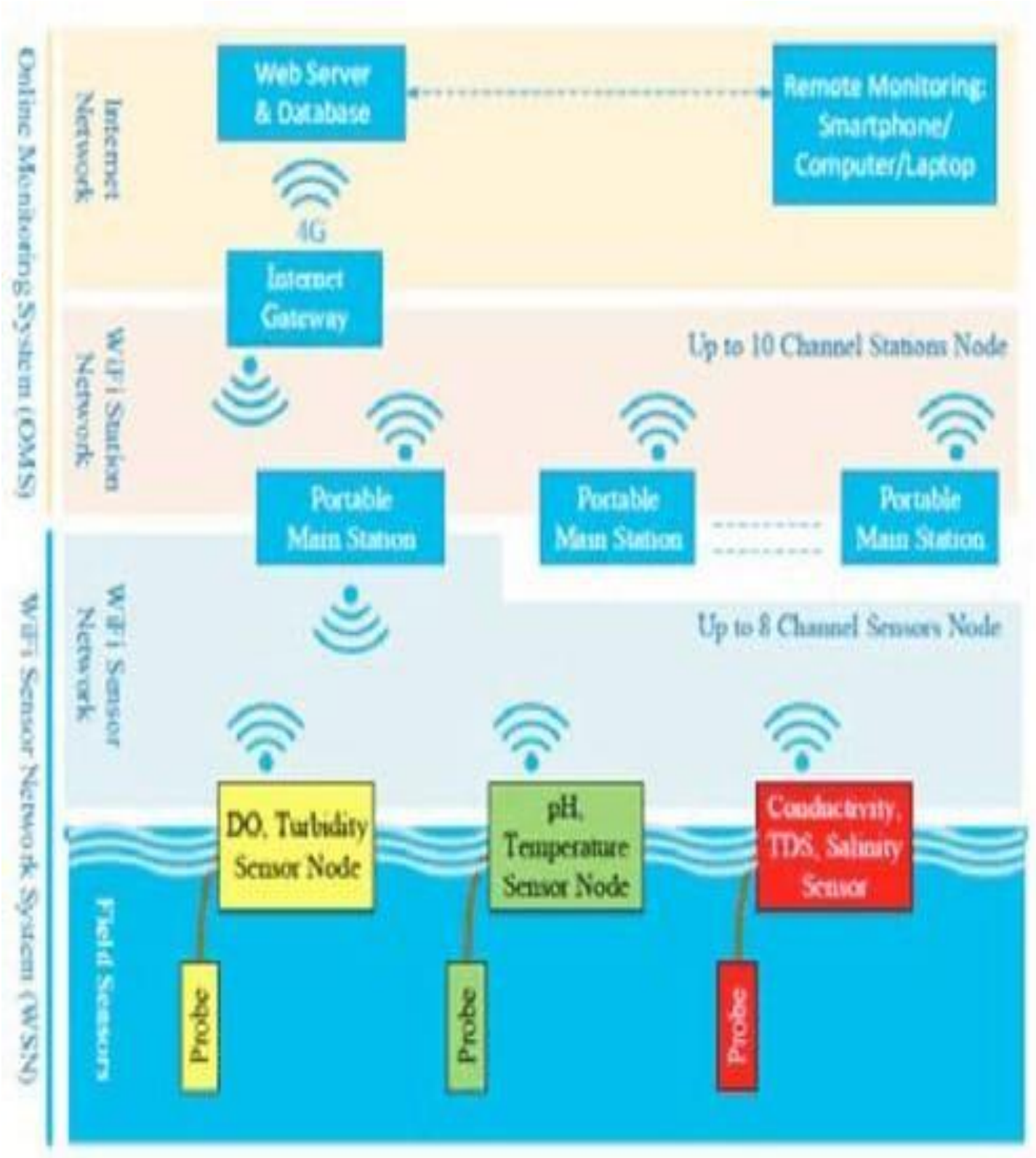


Node red Dashboard:





7.3 Database Schema (If Applicable):



8. TESTING:

8.1 Test Cases:

This report shows the number of test cases that have passed, failed, and untested.

Section	Total caes	**Not Tested**	Fail	Pass
Print Engine	15	0	0	15
Client Application	45	0	0	45
Security	1	0	0	1
Outsource Shipping	2	0	0	2
Exception Reporting	10	0	0	10
Final Report Output	4	0	0	4
Version Control	3	0	0	3

8.2 User Acceptance Testing:

1. Purpose of Document:

The purpose of this document is to briefly explain the test coverage and open issues of the REAL TIME RIVER WATER QUALITY MONITORING AND CONTROL SYSTEMS project at the time of the release to User Acceptance Testing (UAT).

2. Defect Analysis:

This report shows the number of resolved or closed bugs at each severity level, and how they were resolved.

Resolution	**Severity1**	**Severity2**	**Severity3**	**Severity4**	**Sub total**
By Design	9	5	4	3	21
Duplicate	2	0	2	0	4
External	3	4	1	2	10
Fixed	10	1	5	17	33
Not Reproduced	0	0	1	0	1
Skipped	0	0	1	2	3
Won't Fix	0	3	3	1	7
Totals	24	13	17	25	79

9. RESULTS:

In Figure 5 (a), 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 is shown in Figure 5 (b).

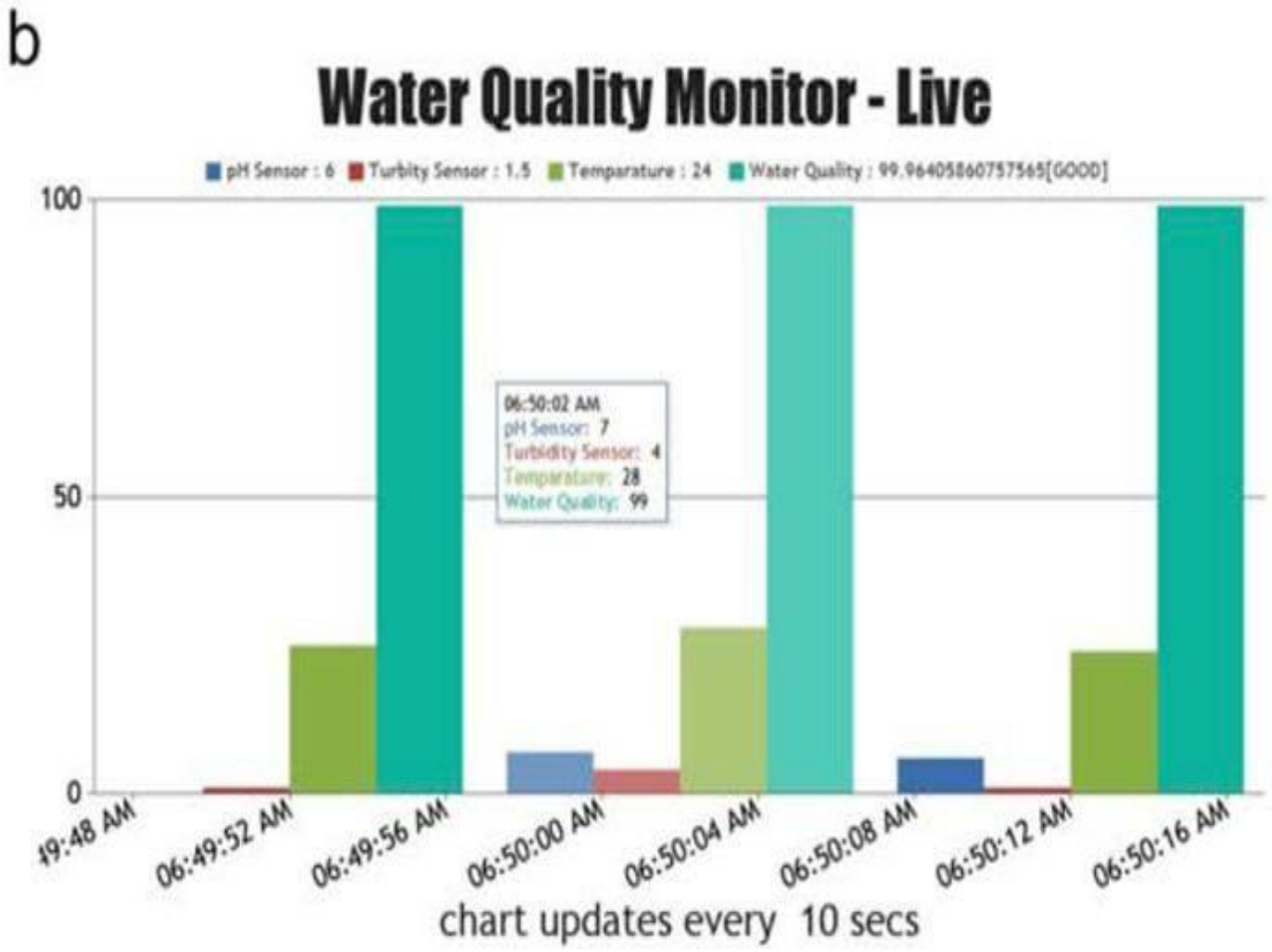


Fig. 5. (a) The figure displays the resulting sensed pH, temp, turbidity, and ORP values.

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.

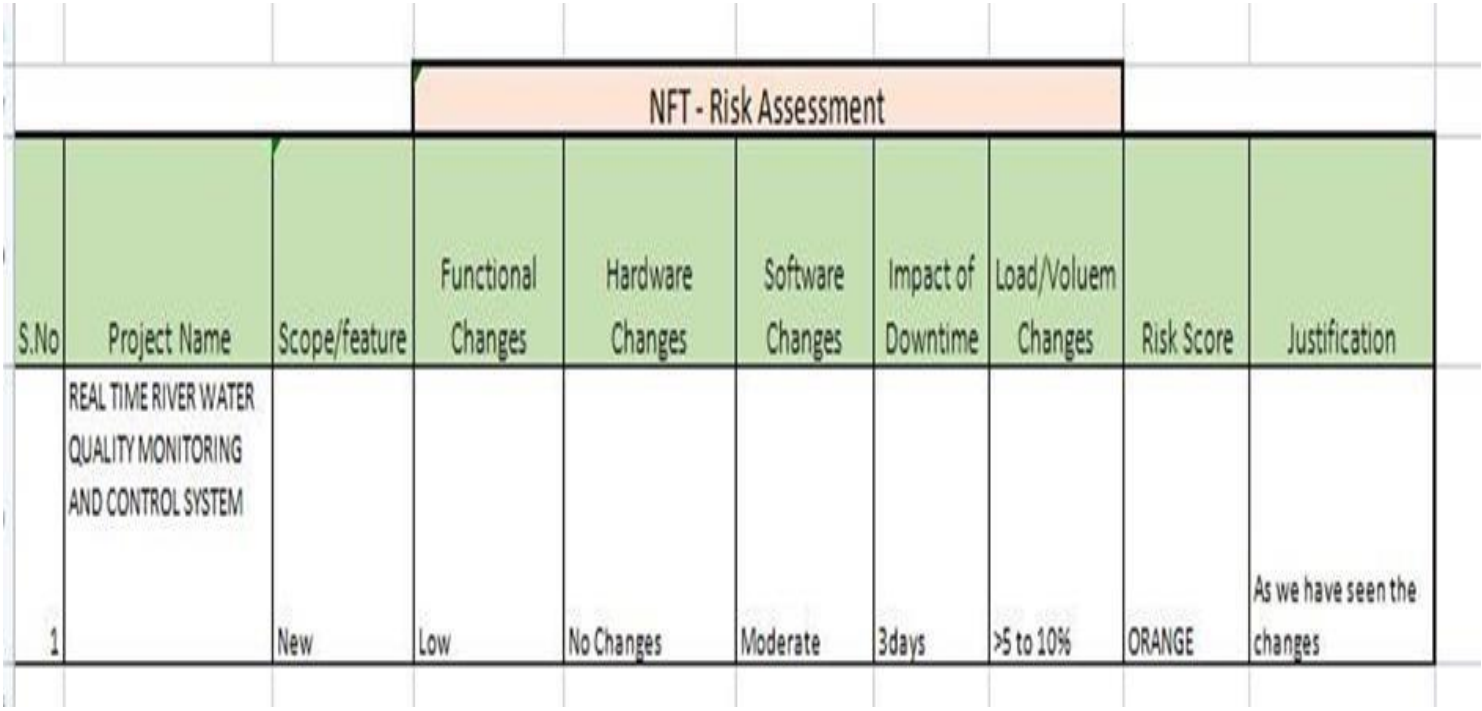
If the acquired value is above the threshold value comments will be displayed as ‘BAD’.

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.

(b) The time series representation of sensor data with decision.

9.1 Performance Metrices:



NFT - Risk Assessment									
S.No	Project Name	Scope/feature	Functional Changes	Hardware Changes	Software Changes	Impact of Downtime	Load/Voluem Changes	Risk Score	Justification
1	REAL TIME RIVER WATER QUALITY MONITORING AND CONTROL SYSTEM	New	Low	No Changes	Moderate	3days	>5 to 10%	ORANGE	As we have seen the changes

PERFORMANCE TABLE

PARAMETER	PERFORMANCE	DESCRIPTION
ADMIN TESTING	95%-100%	THE TESTING DONE BEFORE IT IS DEPLOYED AS AN APP
CUSTOMER SATISFACTION	75-85%	THE CUSTOMER NEED TO BE SATISFIED WITH THE MOBILE APPLICATION
USER INTERFACE	65-85%	THE APP CAN USED BY ANYONE.(EASE OF ACCESS)
SEVER RESPONSE	50-75%	URL- RESPONSE

DATA VALIDATION WITH NO. OF TEST CASE	60-80% (15-30 TESTCASE)	VALID DATA FROM THE APP
ERROR	3-5%	REAL-TIME DELAY MAY OCCUR

10. ADVANTAGES AND DISADVANTAGES:

Advantages:

- The prototype developed for water quality maintenance is very beneficial for safeguarding public health and also adds to the clean environment.
- The automation of this water monitoring, cleaning and control process removes the need of manual labor and thus saves time and money.
- The automation of the system makes the control and monitoring process more efficient and effective. Real time monitoring on mobile phone which is possible through the interface of plc with Arduino and Bluetooth module allows remote controlling of the system.

1. Due to automation it will reduce the time to check the parameters.
2. This is economically affordable for comman people.
3. Provides the prevention from diseases caused by water.

4. Accuracy in measurement 5. SMS alert is sent to the user.

Disadvantages:

- It is difficult to collect the water samples from all the area of the water body.
- The cost of analysis is very high.
- The lab testing and analysis takes some time and hence the lab results do not reflect real time water quality measurement due to delay in measurement.
- The process is time consuming due to slow process of manual data collection from different locations of the water body.
- The method is prone to human errors of various forms.

11.CONCLUSION:

This presents a detailed survey on the tools and techniques employed in existing smart water quality monitoring systems. Also, a low cost, less complex water quality monitoring system is proposed. The implementation enables sensor to provide online data to consumers. The proposed setup can be improved by incorporating algorithms for anomaly detection in water quality. So, this proposed system will surely helpful to the society for safe supply of water. 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 ML lib, 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.

12. FUTURE SCOPE:

We use water detection sensor has unique advantage. It consumes less time to monitor than a manual method for checking polluted levels, and notifies immediately to reduce affected rate of pollution in water.

who are living in rural areas near to the river will be very satisfied with our idea. It will be useful to monitor water pollution in specific area. So, this system prevents people from water pollution.

It will be used for farming purpose to check quality water, temperature and PH level.

Our Impact of this project is also creating a social satisfaction for farmers too. The scalability of this project gives the addition of more different type of sensors. By interfacing the relay we can control the supply of water. We can also implement as a revenue model.

This system could also be implemented in various industrial processes. The system can be modified according to the needs of the user and can be implemented along with lab view to monitor data on computers.

Author contributions

This work was carried out in collaboration between all authors. All the authors have accepted responsibility for the entire content of this submitted manuscript and approved the submission. MSUC, TBE, SG, AP, MMA, NA, and MSH carried out the study design, performed the experiments, data collection, data interpretation, and statistical analysis.

Authors MSUC, TBE, and AP collected the water samples. Authors SG and AP has arranged the software simulation study. Authors TBE and MSH has arranged the biological study.

MSUC, TBE, SG, AP, and MSH designed and planned the studies, supervised the experiments. MSH also acted for all correspondences.

MSUC, TBE, SG, AP, MMA, NA, and MSH participated in the manuscript draft and has thoroughly checked and revised the manuscript for necessary changes in format, grammar and English standard. KA checked the format, grammar and revised the manuscript. All authors read and agreed the final version of the manuscript.

Acknowledgements:

The authors are grateful to both the Department of Computer Science and Engineering.

13. APPENDIX:

13.1 SOURCE CODE:

PYTHON CODE TO PUBLISH DATA:

```
#program to publish data in IBM Watson IOT platform import
time import sys import IBM iotf. Application
 import ibm iotf . Device imports random
#Provide your IBM Watson Device Credentials

#Org_ID organization = "84708c"
#Device Type device Type = "abcd"
#device ID device Id = "12345" #Method
of Authentication auth Method = "token"
#Auth-token auth Token = "12345678"
#Exception handling method
#Try block try: device Options = {"org": organization, "type": device Type, "id":

Device Id, "auth-method”: auth Method, "auth-token”: authToken}
Device Cli= ibmiotf.device.Client (device Options)
```

```
#To handle the errors except Exception
as e:
        print ("Caught evention connecting device: %s" % str(e)) sys. Exit ()
#device connection device Cli. connect()
#While Loop for getting the values while True:
    Ph=random.
    randint (6,8)
    Water              Turbidity=random.randint              (15,100)
    salinity=random. randint (500,1000)
     Dissolved           Oxygen=random.randint           (60,130)
    conductivity=random.randint (100,1200) data = {'Ph' : Ph,
'WaterTurbidity':WaterTurbidity,'salinity':salinity,'DissolvedOxygen':
Dissolved Oxygen, 'conductivity': conductivity}
    #define myonpublishcallback function def

    myonPublishCallback():
print ("Published Ph = %s" % Ph, "Water Turbidity = %s %%" %
Water Turbidity, "salinity = %s" % salinity,"DissolvedO2 = %s" %
Dissolved Oxygen, "conductivity = %s" % conductivity) if (Ph<7.4 and salinity
        < 600 and Dissolved Oxygen < 80 and

conductivity < 200): if (Ph>7.4 and salinity > 900 and Dissolved Oxygen > 120 and
conductivity > 1100):
print ("UNSAFE, THE VALUES OF PARAMETERS ARE
NOT IN THE RANGE") else: print ("Quality of River water is measured and its
        correct")
```

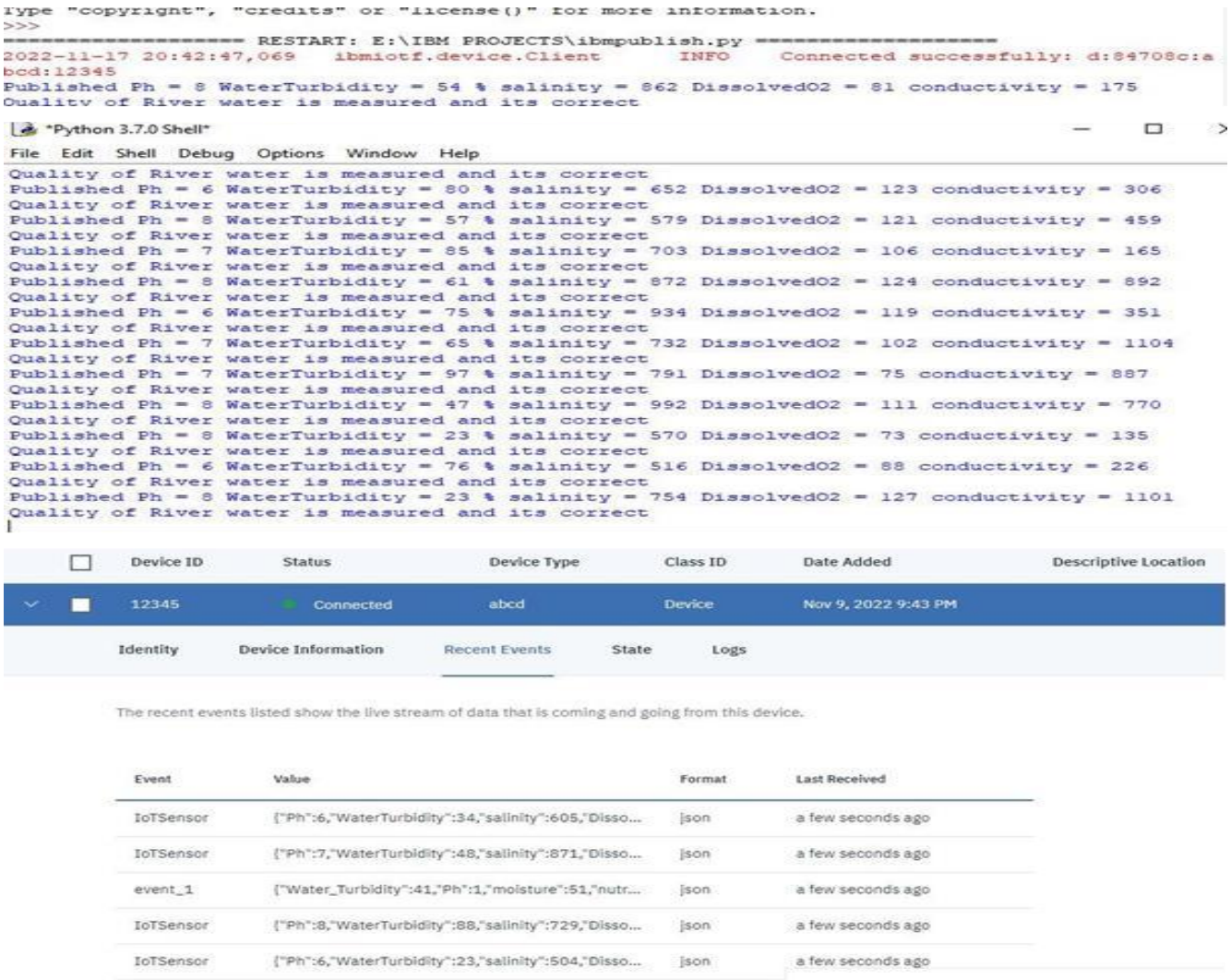
success = device Cli. Publish Event ("IoT Sensor", "json", data, qos=0,

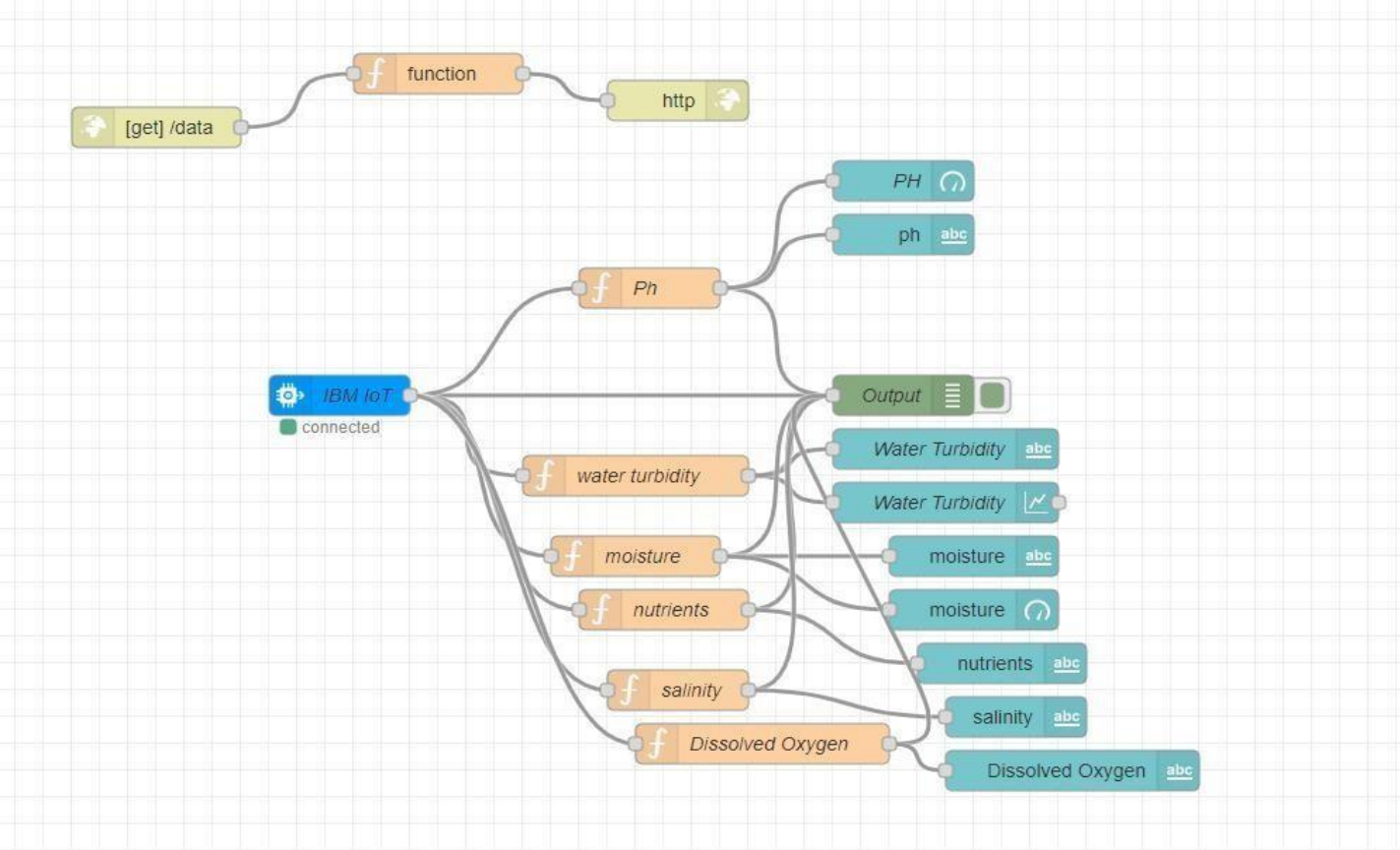
on_publish = myonPublishCallback) if not success:

print ("Not connected to IOTF")

#Sleep time. Sleep (10) #disconnect device device Cli. Disconnect ()

OUTPUT:



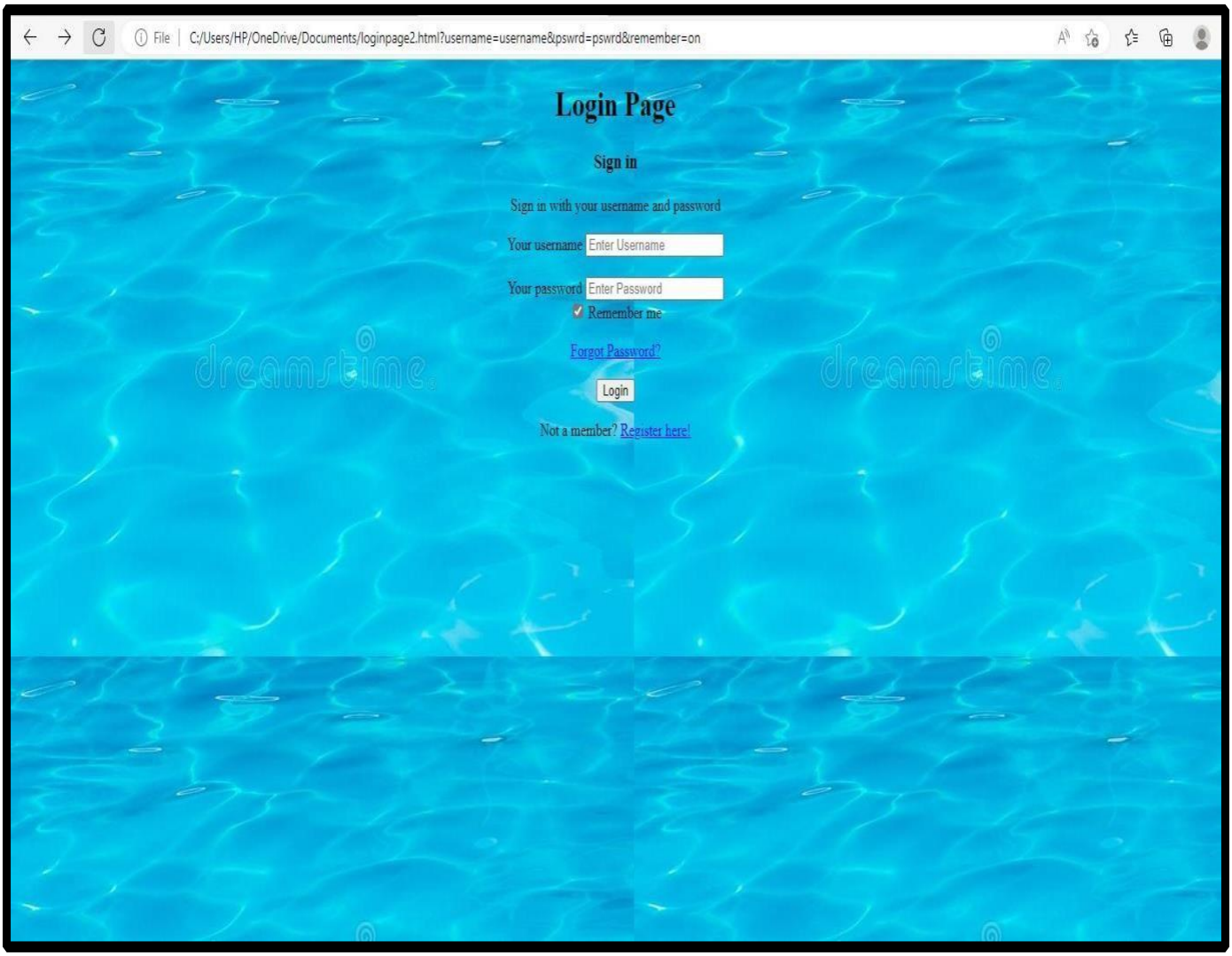


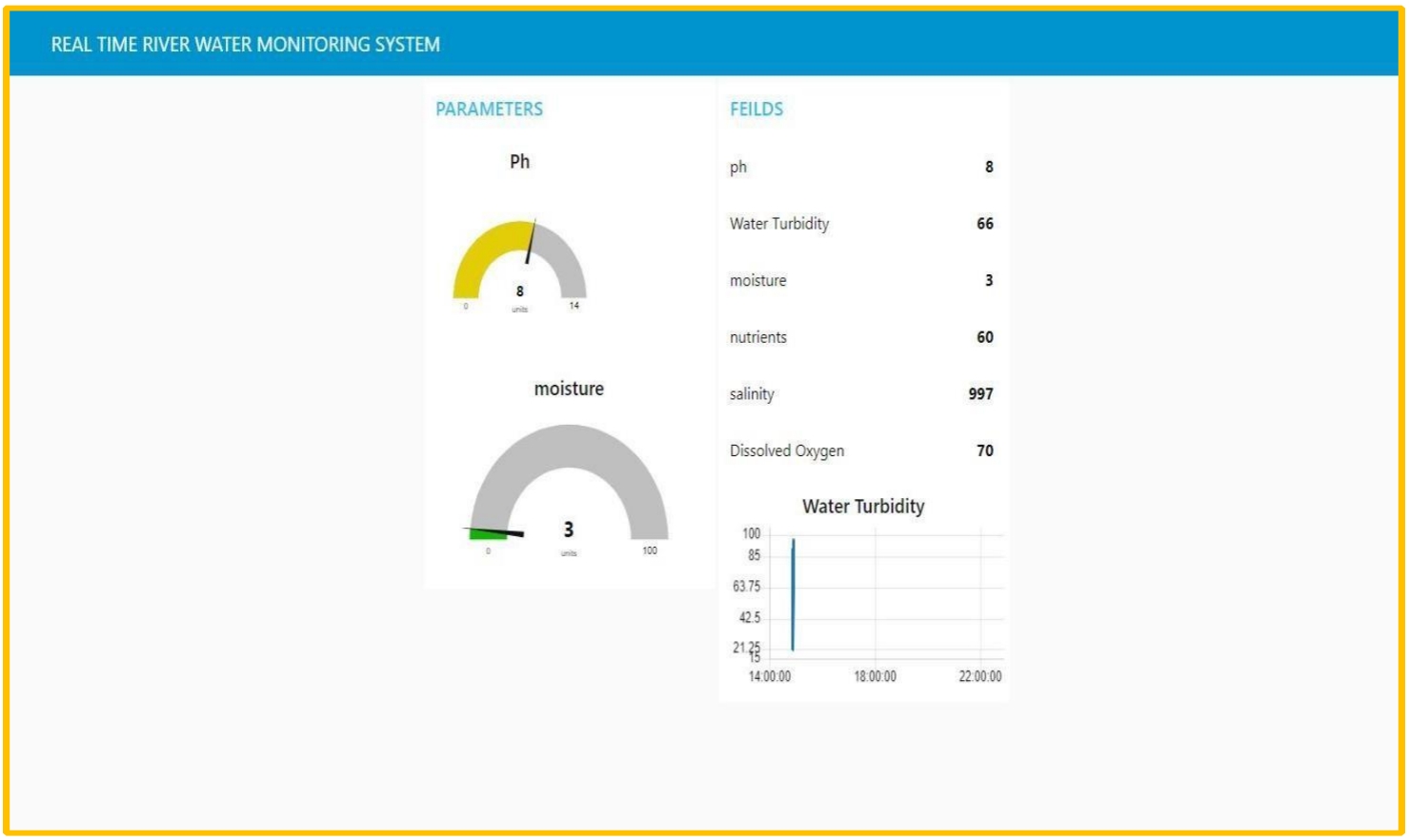
HTML CODE:

```
<!DOCTYPE html>
<html lang= "en" >
<head>  <style>  h1  {text-align:
  center;} p {text-align: center;} div
  {text-align: center;} body {
background-image: url ("https://thumbs.dreamstime.com/b/clear-transparent-light-blue-water-pool-texture-background-150961732.jpg");  background-color:
    #cccccc;
   }
  </style>
  <meta charset="UTF-8">
  <meta http-equiv="X-UA-Compatible" content="IE=edge">
  <meta name="viewport" content="width=device-width, initial-scale=1.0">
  <title>Login page in HTML</title>
</head>
```

```
<body>
  <h1>Login Page</h1>
  <form action="">
    <! -- Headings for the form -->
    <div class="headings Container">
      <h3>Sign in</h3>
      <p>Sign in with your username and password</p>
    </div>

    <! -- Main container for all inputs -->
    <div class="main Container">
      <! -- Username -->
      <label for="username">Your username</label>
      <input type="text" placeholder="Enter Username" name="username" required>

      <br><br>

      <! -- Password -->
      <label for="pswrd">Your password</label>
      <input type="password" placeholder="Enter Password" name="pswrd" required>

      <! -- sub container for the checkbox and forgot password link -->
      <div class="subcontainer">
        <label>
<input type="checkbox" checked="checked" name="remember"> Remember me
        </label>
        <p class="forgotpsd"> <a href="#">Forgot Password?</a></p>
      </div>
      <button type="submit" onclick="window.location.href = 'https://node-red-qltdp-2022-
11-07.eu-gb.mybluemix.net/ui';">Login</button>
```

```
        <! -- Sign up link -->
<p class="register">Not a member? <a href="#">Register here!</a></p>


      </div>
    </p>


  </form>
</body>
</html>
```

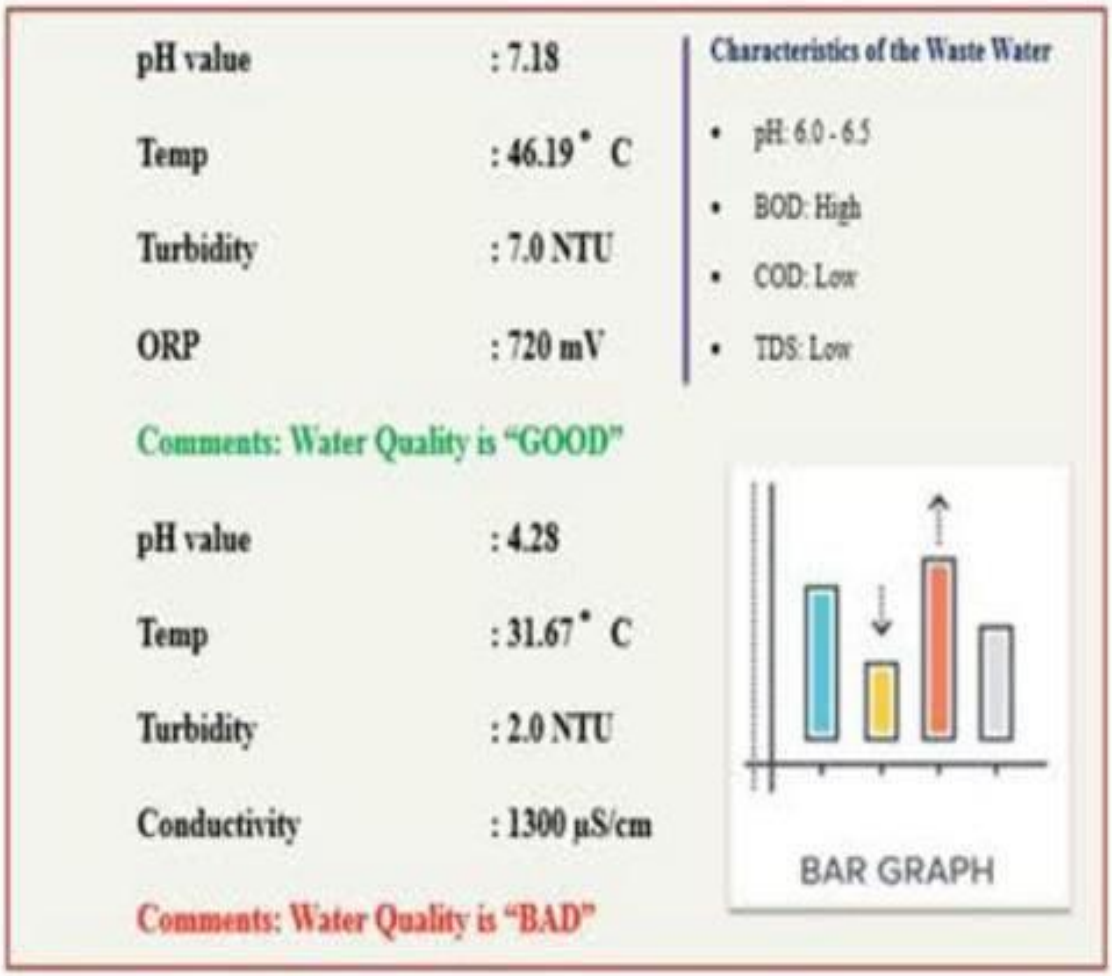



REAL TIME RIVER WATER MONITORING SYSTEM
PARAMETERS
Ph
8
0
14
units
moisture
3
0
100
units
FEILDS
ph 8
Water Turbidity 66
moisture 3
nutrients 60
salinity 997
Dissolved Oxygen 70
Water Turbidity
100
85
63.75
42.5
21.25
15
14:00:00
18:00:00
22:00:00

MOBILE APP:


WATER QUALITY TEST
Water Turbidity
93
Ph
7
moisture
45
nutrients
49
salinity
36
dissolved O2
44
NEXT PAGE
PUBLIS H

a



13.2 GitHub Link:

https://github.com/IBM-EPBL/IBM-Project-51278-1660977114