

# **REAL-TIME RIVER WATER QUALITY MONITORING AND CONTROL SYSTEM**

**A PROJECT REPORT**

*by*

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**NOVEMBER 2022**

**ANNA UNIVERSITY : CHENNAI 600 025**

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## **ABSTRACT**

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. The environment consists of five key elements e.g., soil, water, climate, natural vegetation, and landforms. Among these water is the major need of 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. 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.

## **CHAPTER 1**

### **INTRODUCTION**

#### **1.1 PROJECT OVERVIEW**

River Water Quality Monitoring is the major tasks for upcoming generation as Water Pollution rates are increasing day by day. People who are not researchers are most likely to intersect environmental science in the context of protecting or restoring a place or species about which they are concerned, or in the context of pollution—trying to understand the sources and effects of contaminants, or trying to prevent or remediate environmental contamination. The works in this entry address pollutants affecting river ecosystems, including the people who live within or use resources from those ecosystems. Pollution is commonly subdivided based on the primary medium affected by contamination, creating categories such as air pollution, soil pollution, freshwater pollution, groundwater pollution, or marine pollution. In reality, of course, all of these media are intimately connected. Atmospheric deposition of contaminants pollutes soil and water bodies. Contaminated groundwater seeps into rivers, and contaminated rivers recharge groundwater aquifers. Fluxes of water, sediment, solutes, and even organisms carrying contaminants within their tissues create vectors to disperse pollutants. This is one of the great challenges to understanding and mitigating pollution: the contaminant is seldom an inert substance that stays in one place.

Another great challenge is that there are many different types of contaminants, including human and animal wastes such as sewage or intestinal bacteria, excess nutrients, heavy metals, petroleum products, radioactive isotopes, and an enormous array of synthetic chemicals such as pesticides and personal care products. Each type of contaminant can disperse through environmental media, combining with other chemical compounds to form metabolites that may have different levels of toxicity for organisms or different dispersal mechanisms than the original contaminant. Yet another challenge in understanding and managing pollutants is that a substance that is harmful to one type of organism may not cause harm to another

environmental standards set by government agencies for maximum permissible levels of contaminants are based on very limited knowledge and are likely to be inadequate. Most of the standards are also based on acute effects that show up very quickly. Contaminant levels below permissible standards can cause chronic effects—subtle but pervasive changes that eventually degrade the health of individual organisms and populations. Some chronic effects result from bioaccumulation, as an organism accumulates contaminants within its tissues over the course of its life, and bio-magnification, as organisms pass on their accumulated doses to predators or scavengers.

## **1.2 PURPOSE**

Current water quality monitoring system is a manual system with a monotonous process and is very time-consuming. It is 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.

In this project, we have used IBM Watson IoT platform as our core platform for our project. The project starts with the Python Script, while running the code the description connects with the Cloud platform and generates the output.

## **CHAPTER 2**

### **LITERATURE SURVEY**

#### **2.1 EXISTING PROBLEM**

New sensor capacities and executions are being created by remote correspondence. For natural applications, late advancements in sensor organizing are fundamental. The Things Web (IoT) permits joins between various gadgets to share and gather information. Notwithstanding mechanization, IoT grows its capacities by utilizing Industry to determine natural worries. Since water is one of the key prerequisites of human endurance and life submerged, some instrument is important to control water quality infrequently. Wireless communication developments are creating new sensor capabilities. The current developments in the field of sensor networks are critical for environmental applications. Internet of Things (IoT) allows connections among various devices with the ability to exchange and gather data. IoT also extends its capability to environmental issues in addition to automation industry by using industry 4.0. Around 40% of deaths are caused due to contaminated water in the world. Hence, there is a necessity to ensure supply of purified drinking water for the people both in cities and villages. Water Quality Monitoring (WQM) is a cost-effective and efficient system designed to monitor drinking water quality which makes use of Internet of Things (IoT) technology.

Water quality monitoring (WQM) system is widely being explored as it is needed to prevent the problem of water contamination worldwide. This paper proposed an independent robot busy with constant multisensory (pH, temperature, voltage and trash level) for better water quality.

The information were recorded utilizing sensors and communicated by means of Wi-Fi to a planned MIT creator versatile application and put away in the cloud to screen the water quality. This paper presents the development and implementation of Water Quality Assessment and Monitoring (WQAM) system. The system development used WiFi enabled microcontroller to connect with the IoT environment and store the data in the IoT cloud server. The microcontroller used is Arduino UNO that interacts with three types of sensor probes which are pH, turbidity and temperature probe. All the data measurements is transferred using a WiFi module which is ESP8266. The IoT cloud used to utilize the data frame is ThingSpeak. This system was implemented on Bandar Perda Lake and Derhaka River in Pulau Pinang with two systems implemented at each location. The sensors were placed on the water surface for more accurate measurements. This system continuously measures the readings of pH, turbidity dan temperature on the lake/river for every 1 hour. Twenty readings were taken for every 1 hour within the first 20 minutes with 1 minute interval and the readings were stored in the IoT cloud server. The readings are accessible via ThingSpeak GUI. In conclusion, this system would benefit the authorities to take advantage of using the WQAM system with the aid of the IoT that is less time consuming, less cost and more reliable in real time.

Our main aim is to develop a system for continuous monitoring of river water quality at remote places using wireless sensor networks with low power consumption, low-cost and high detection accuracy. pH, conductivity, turbidity level, etc. are the limits that are analyzed to improve the water quality. Following are the aims of idea implementation: a. To measure water parameters such as pH, dissolved oxygen, turbidity, conductivity, temperature etc. using available sensors at remote place. b. To collect data from various sensor nodes and send it to base station by wireless channel. c. To simulate and analyze quality parameters for quality control. d. To send SMS to an authorized person automatically when water quality detected does not match the preset standards, so that, necessary actions can be taken.



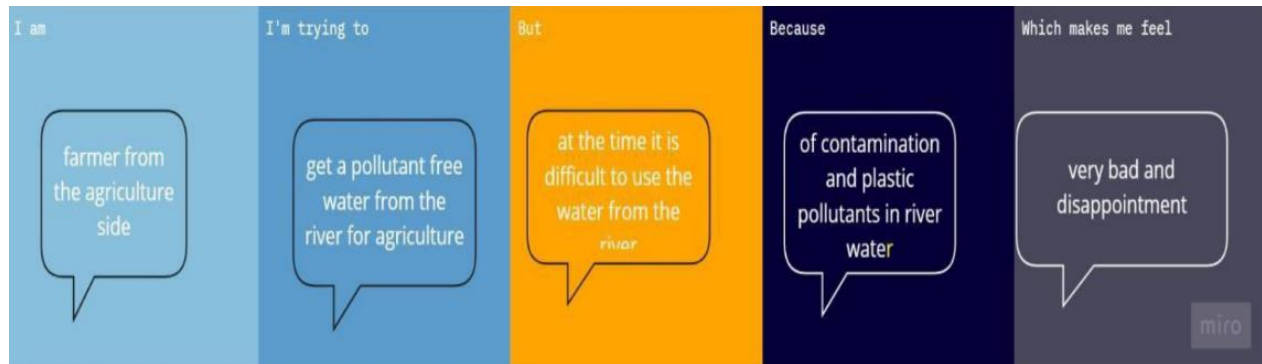
## 2.2 REFERENCES

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## 2.3 PROBLEM STATEMENT DEFINITION

A problem statement is important to a process improvement project because it helps clearly identify the goals of the project and outline the scope of a project. It also helps guide the activities and decisions of the people who are working on the project. The problem statement can help a business or organization gain support and buy-in for a process improvement project.

Creating a problem statement to understand customer's point of view. The below shown block diagram is a perfect example for our topic.



## CHAPTER 3

### IDEATION & PROPOSED SOLUTION

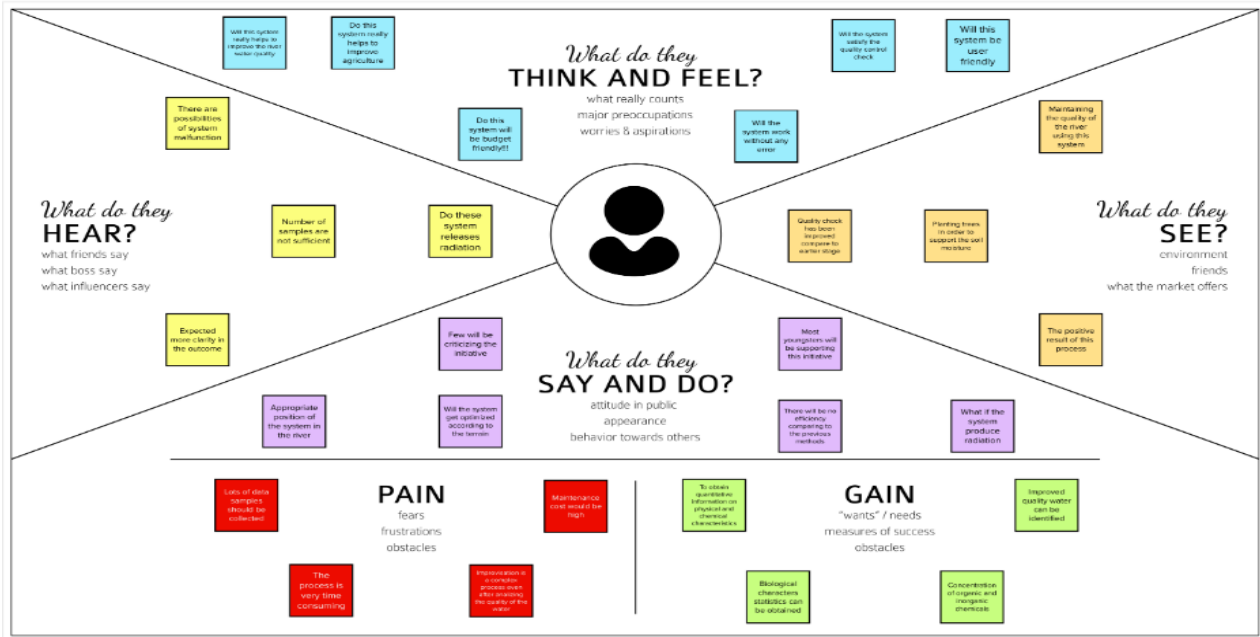
#### 3.1 EMPATHY MAP CANVAS

# Empathy Map Canvas

Gain insight and understanding on solving customer problems.

1

Build empathy and keep your focus on the user by putting yourself in their shoes.



Share your feedback

Empathy maps are an efficient tool used by designers to not only understand user behaviour, but also visually communicate those findings to colleagues, uniting the team under one shared understanding of the user. Essentially, an empathy map is a square divided into four quadrants with the user or client in the middle. Each of the four quadrants comprises a category that helps us delve into the mind of the user. The four empathy map quadrants look at what the user **says**, **thinks**, **feels**, and **does**.

With the user at the centre and the categories in each of the four surrounding quadrants, an empathy map arranges all of your research about the user into an easy-to-read visual.

## 3.2 IDEATION & BRAINSTORMING

### 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

Define your problem statement?

PROBLEM: HOW MIGHT WE DESIGN A DEVICE TO MONITOR THE QUALITY OF WATER IN THE RIVER AND PROVIDE A WARNING?

Key rules of brainstorming

To run an smooth and productive session

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

### 2 Brainstorm

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

10 minutes

Charlotte Walker

Beneth Raj

Ally Parnell

Alannah Thomas

Handwritten notes and sticky notes on a grid, organized by person. Topics include: sensor based, Water Parameters, Analysis, Work, and specific ideas like 'arduino and sensor based parameters water monitoring', 'pH, turbidity, temperature sensors connected with arduino', 'predicting the algal bloom graph', 'semi automated or manual control devices for checking pH turbidity and water temperature value', 'ultrasonic radiation for algae control', 'statistical recording of pH temperature values in data storing method', 'predicting the growth of algae using conventional method', 'manual checking of water contamination by paper report', 'statistical recording of pH temperature values in data storing method', 'ultrasonic radiation for algae control', 'GSM modules to collect and transfer water quality data to mobile applications'.

### 3 Group ideas

Take turns sharing your ideas while clustering similar or related notes as you go. Once all sticky notes have been grouped, give each cluster a sentence-like label. If a cluster is bigger than six sticky notes, try and see if you can break it up into smaller sub-groups.

20 minutes

sensor based

Water Parameters

Analysis

Work

Handwritten notes and sticky notes on a grid, organized by category. Topics include: 'arduino and sensor based parameters water monitoring', 'ultrasonic radiation for algae control', 'pH, turbidity, temperature sensors connected with arduino', 'statistical recording of pH temperature values in data storing method', 'predicting the algal bloom graph', 'predicting the growth of algae using conventional method', 'semi automated or manual control devices for checking pH turbidity and water temperature value', 'manual checking of water contamination by paper report'.

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sensor based

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### 5 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

Importance

Feasibility

Handwritten notes and sticky notes on a grid, organized by importance and feasibility. Topics include: 'manual checking of water contamination by paper report', 'statistical recording of pH temperature values in data storing method', 'ultrasonic radiation for algae control', 'GSM modules to collect and transfer water quality data to mobile applications', 'predicting the growth of algae using conventional method', 'statistical recording of pH temperature values in data storing method', 'ultrasonic radiation for algae control', 'pH, turbidity, temperature sensors connected with arduino', 'semi automated or manual control devices for checking pH turbidity and water temperature value', 'manual checking of water contamination by paper report'.

### 6 After you collaborate

You can export the mural as an image or pdf to share with members of your company who might find it helpful.

20 minutes

Quick add-ons

Share the mural

Export the mural

Keep moving forward

Strategy blueprint

Customer experience journey map

Strengths, weaknesses, opportunities & threats

Show template feedback

Fig3.Brainstorming

Brainstorming is a method design teams use to generate ideas to solve clearly defined design problems. Brainstorming is a method of generating ideas and sharing knowledge to solve a particular commercial or technical problem, in which participants are encouraged to think without interruption. Brainstorming is a group activity where each participant shares their ideas as soon as they come to mind. At the conclusion of the session, ideas are categorised and ranked for follow-on action.

When planning a brainstorming session it is important to define clearly the topic to be addressed. A topic which is too specific can constrict thinking, while an ill-defined topic will not generate enough directly applicable ideas. The composition of the brainstorming group is important too. It should include people linked directly with the subject as well as those who can contribute novel and unexpected ideas. It can comprise staff from inside or outside the organisation.

### **3.3 PROPOSED SOLUTION**

Proposed Solution means the technical solution to be provided by the Implementation agency in response to the requirements and the objectives of the Project.

To measure water parameters such as pH, dissolved oxygen, turbidity, conductivity, etc. using available sensors at a remote place. To assemble data from various sensor nodes and send it to the base station by the wireless channel. To simulate and evaluate quality parameters for quality control. To send SMS to an authorized person routinely when water quality detected does not match the preset standards, so that, necessary actions can be taken.

S.No	Parameter	Description
1.	Problem Statement (Problem to be solved)	To monitor the water parameters such as turbidity ,pH, dissolved solvents and to analyse the quality of river water.
2.	Idea / Solution description	Monitoring water parameters with sensors and control measures by ultrasonic frequencies.
3.	Novelty / Uniqueness	Arduino And Sensor Based Water Parameters Monitoring which identifies biological and chemical changes in water
4.	Social Impact / Customer Satisfaction	It provides the user with an idea about the quality of river water which might help them to base the usage of the water according to its quality.
5.	Business Model (Revenue Model)	The monitoring system could be sold in the market for the purpose of testing water quality.
6.	Scalability of the Solution	The model could be scaled according to size of the water body about to be tested.

### 3.4 PROBLEM SOLUTION FIT

## Problem-Solution fit canvas 2.0

Purpose / Vision

Define CS, fit into CC	<b>1. CUSTOMER SEGMENT(S)</b> <span>CS</span> Who is your customer? i.e. working parents of 0-5 y.o. kids <ul style="list-style-type: none"> <li>Quality of the water</li> <li>Customer safety(personal use)</li> </ul>	<b>6. CUSTOMER CONSTRAINTS</b> <span>CC</span> What constraints prevent your customers from taking action or limit their choices of solutions? i.e. spending power, budget, no cash, network connection, available devices. <ul style="list-style-type: none"> <li>Without water no life could exist and many essential and non essential human activities wouldn't be possible without the healthy water shades</li> <li>Hydrological factors and biological process in the aquatic environment</li> </ul>	<b>5. AVAILABLE SOLUTIONS</b> <span>AS</span> Which solutions are available to the customers when they face the problem or need to get the job done? What have they tried in the past? What pros & cons do these solutions have? i.e. pen and paper is an alternative to digital notetaking <ul style="list-style-type: none"> <li>A stream or river monitoring project can also require the observation and measurement of water quality</li> <li>To make a device which will maintain accuracy and keep equipment functioning within specifications, best practice recommends cleaning and calibrating the instruments at regular intervals</li> </ul>	Explore AS, differentiate
	<b>2. JOBS-TO-BE-DONE / PROBLEMS</b> <span>J&amp;P</span> Which jobs-to-be-done (or problems) do you address for your customers? There could be more than one, explore different sides. <ul style="list-style-type: none"> <li>Hard to read the data from the river water</li> <li>Finding a perfect place to measure the accuracy</li> <li>Possibility of malfunction of sensors placed in the river water</li> <li>Damage of sensors due to external factors in the river water</li> </ul>	<b>9. PROBLEM ROOT CAUSE</b> <span>RC</span> What is the real reason that this problem exists? What is the back story behind the need to do this job? i.e. customers have to do it because of the change in regulations. <ul style="list-style-type: none"> <li>The growth of excessive algae is called eutrophication leads to pollution</li> <li>Excessive use of oxygen in the water leads to death of all organisms living in the water</li> </ul>	<b>7. BEHAVIOUR</b> <span>BE</span> What does your customer do to address the problem and get the job done? i.e. directly related: find the right solar panel installer, calculate usage and benefits; indirectly associated: customers spend free time on volunteering work (i.e. Greenpeace) <ul style="list-style-type: none"> <li>Various types of sensors can be attached according to various dimensions of the river</li> <li>Solution architecture of the system place a major role in this process(MVP Model)</li> </ul>	
Identify strong TR & EM	<b>3. TRIGGERS</b> <span>TR</span> What triggers customers to act? i.e. seeing their neighbour installing solar panels, reading about a more efficient solution in the news. <ul style="list-style-type: none"> <li>People want to check the purity of the water they are using in an easier and accurate method</li> <li>Public are aware about the purity of water they are using</li> </ul>	<b>10. YOUR SOLUTION</b> <span>SL</span> If you are working on an existing business, write down your current solution first, fill in the canvas, and check how much it fits reality. If you are working on a new business proposition, then keep it blank until you fill in the canvas and come up with a solution that fits within customer limitations, solves a problem and matches customer behaviour. <ul style="list-style-type: none"> <li>The specifics of your stream or river monitoring system will depend largely on the requirements of your project, as well as site conditions at the waterway.</li> <li>While every stream or river monitoring system may not require a full stream gage installation with stilling well and associated instruments, it may be helpful to consider what such a system should entail as determined by the country's preminent river</li> </ul>	<b>8. CHANNELS of BEHAVIOUR</b> <span>CH</span> <b>8.1 ONLINE</b> What kind of actions do customers take online? Extract online channels from #7 <ul style="list-style-type: none"> <li>Video tutorial is made to bring awareness among the people</li> <li>The advertisements can be done in the social media</li> </ul> <b>8.2 OFFLINE</b> What kind of actions do customers take offline? Extract offline channels from #7 and use them for customer development. <ul style="list-style-type: none"> <li>Creating awareness by advertising with sign boards in public places</li> </ul>	Extract online & offline CH of BE
	<b>4. EMOTIONS: BEFORE / AFTER</b> <span>EM</span> How do customers feel when they face a problem or a job and afterwards? i.e. lost, insecure > confident, in control - use it in your communication strategy & design. <ul style="list-style-type: none"> <li>Public are not aware of the quality of the water they are using</li> <li>After the implementation of the project people are well aware of the water quality</li> </ul>			

## CHAPTER 4

## REQUIREMENT ANALYSIS

## 4.1 FUNCTIONAL REQUIREMENTS

FR No.	Functional Requirement (Epic)	Sub Requirement (Story / Sub-Task)
FR-1	Users Authorization levels	Complete mapping are given in a hierarchical manner in order to show only the specific Data.
FR-2	Historical Data	The Data are stored in the cloud from the beginning stage till the Updation .
FR-3	User Authentication	The credentials is accessible only to the authorized users to access the model.
FR-4	Users rules and laws	There is some specific guidelines which has to be followed by the users.

## 4.2 NON FUNCTIONAL REQUIREMENTS

FR No.	Non-Functional Requirement	Description
NFR-1	<b>Usability</b>	The Final data should be easily understandable .
NFR-2	<b>Security</b>	The model are designed in a secured manner in order to maintain the privacy
NFR-3	<b>Reliability</b>	Even if there is a firmware issues (failures) the last updated Data's are stored in a Default manner.
NFR-4	<b>Performance</b>	High quality sensors are used to ease the customer's work.
NFR-5	<b>Availability</b>	The model are designed in such a way that are available ,usable and can be modified anytime.
NFR-6	<b>Scalability</b>	The System are Scaled according to the size of the water body (varies)

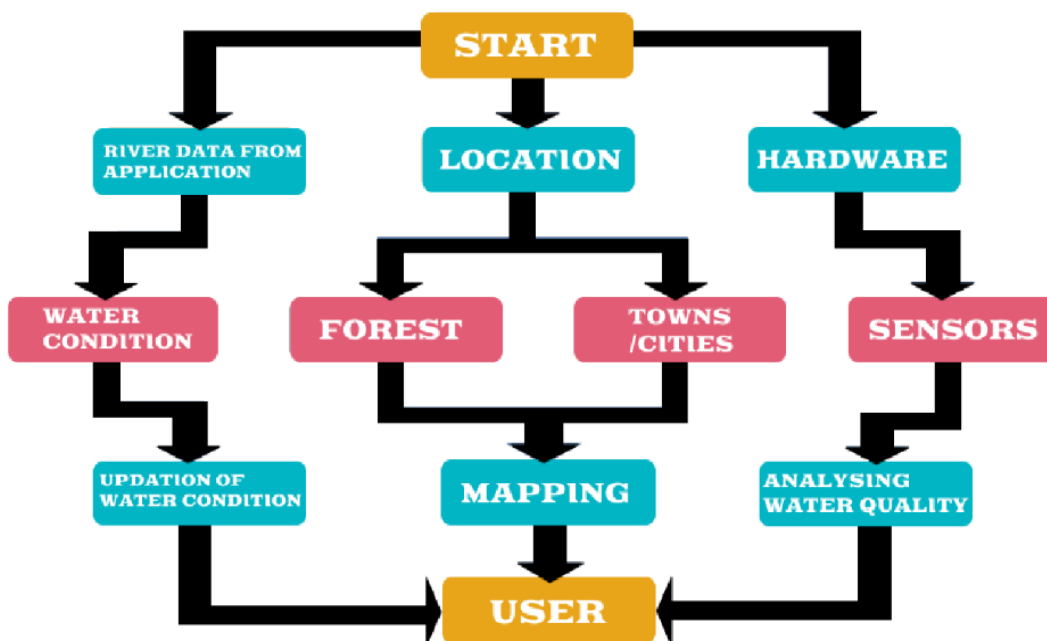
## CHAPTER 5



## PROJECT DESIGN

### 5.1 DATA FLOW DIAGRAM

The Data Flow Graph of our proposed solution is shown below:



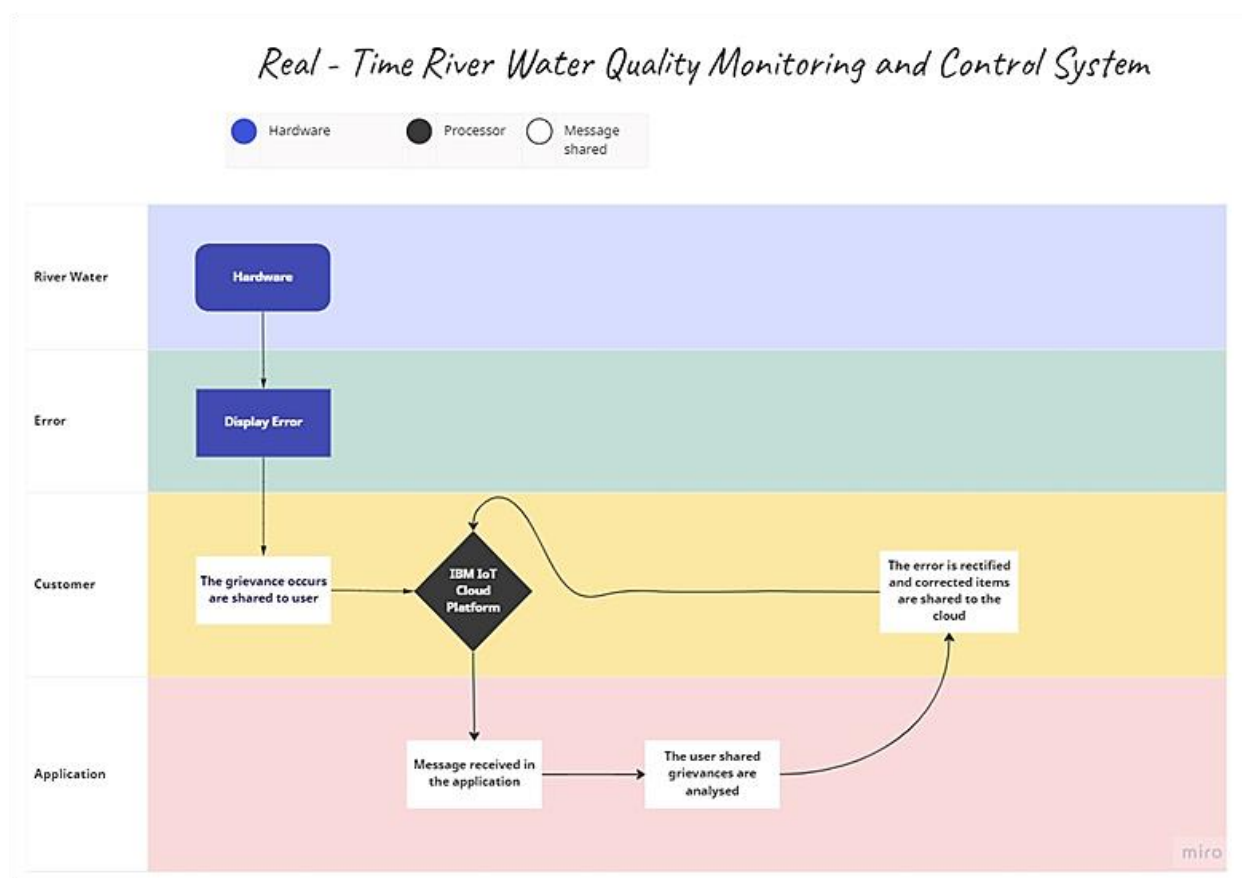
A data-flow graph is a collection of arcs and nodes in which the nodes are either places where variables are assigned or used, and the arcs show the relationship between the places where a variable is assigned and where the assigned value is subsequently used.

Our Data Flow Diagram shows the entire process from the entry of the Application to the exit which is controlled by the User. Here, after the user login the app moves on to the profile section where the user can see the materials to be selected then the measurement what he need to acquire is to be chosen.

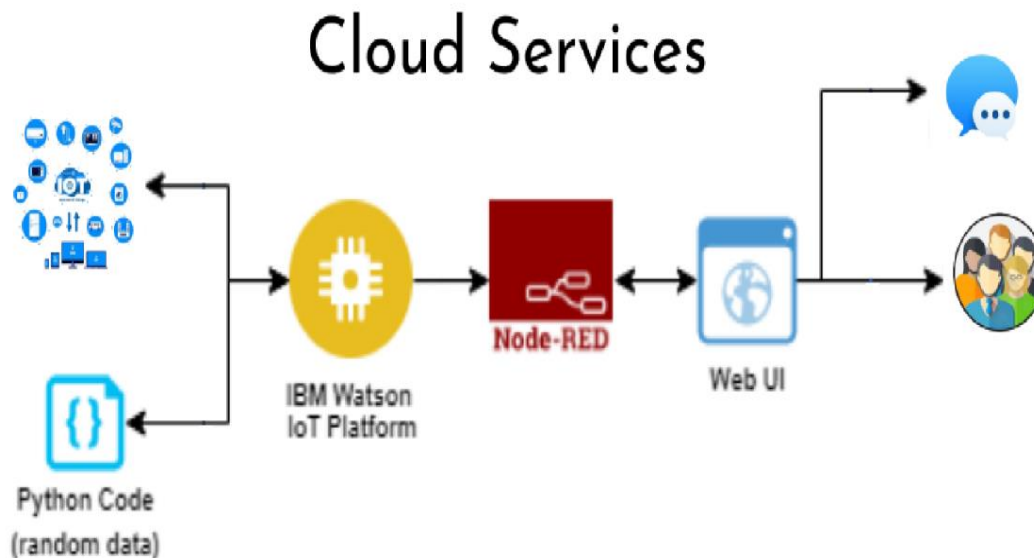
## 5.2 SOLUTION & TECHNICAL ARCHITECTURE

For Solution Architecture,

- The Quality of the Water will be determined by our IoT process.
- While consuming the impure water causing various diseases, this can be stopped by Controlling pollutants.
- We provide proper solution to overcome this disaster.



Technical Architecture:



Technical architecture—which is also often referred to as application architecture, IT architecture, business architecture, etc.—refers to creating a structured software solution that will meet the business needs and expectations while providing a strong technical plan for the growth of the software application through its lifetime. IT architecture is equally important to the business team and the information technology team.

Technical architecture includes the major components of the system, their relationships, and the contracts that define the interactions between the components. The goal of technical architects is to achieve all the business needs with an application that is optimized for both performance and security. IT architects plan for things they know are coming in the future and for things they don't yet envision or dream. Taking the time to design the architecture at the start will prevent major design changes, code refactoring, and expensive rework later in the project.

## 5.3 USER STORIES

A user story is an informal, general explanation of a software feature written from the perspective of the end user. Its purpose is to articulate how a software feature will provide value to the customer. It's tempting to think that user stories are, simply put, software system requirements. But they're not.

A key component of agile software development is putting people first, and a user story puts end users at the center of the conversation. These stories use nontechnical language to provide context for the development team and their efforts. After reading a user story, the team knows why they are building, what they're building, and what value it creates. User stories are one of the core components of an agile program. They help provide a user-focused framework for daily work — which drives collaboration, creativity, and a better product overall.

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 a 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 email	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	USN-7	As a 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 (input)	View manner	USN-8	As a user, I can view data in visual representation manner(graph)	I can easily understand by visuals.	High	Sprint-1
	Taste	USN-9	As a user, I can able to view the quality(salty) of the water	I can easily know whether it is salty or not	High	Sprint-1
	Colour visibility	USN-10	As a user, I can able predict the water colour	I can easily know the condition by colour	High	Sprint-1
Administrator	Risk tolerant	USN-11	An administrator who is handling the system should update and take care of the application.	Admin should monitor the records properly.	Medium	Sprint-2

## CHAPTER 6

### PROJECT PLANNING & SCHEDULING

#### 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	CHANDRA MOHAN, AKASH THOMAS,
	Registration via Mail ID	USN-4	As a user, I can register for the application through Gmail	2	Medium	AJAY PRASAD
Sprint-2	Confirmation	USN-2	As a user, I will receive confirmation email once I have registered for the application	1	High	
	Login	USN-5	As a user, I can log into the application by entering email & password	1	Medium	
	IBM Cloud service Access		Get access to IBM cloud services.	2	High	
Sprint-3	Create the IBM Watson IoT and device settings	USN-6	To create the IBM Watson IoT Platform and integrate the microcontroller with it, to send the sensed data on Cloud	2	Medium	BARATH RAJ, AJAY PRASAD
	Create a node red service	USN-7	To create a node red service to integrate the IBM Watson along with the Web UI	2	low	AKASH THOMAS ,AJAY PRASAD
	Create a Web UI	USN-8	To create a Web UI, to access the data from the cloud And display all parameters.	2	Medium	BARATH RAJ
Sprint-4	Publish Data to cloud.	USN-10	Publish Data that is sensed by the microcontroller to the Cloud	3	High	AKASH THOMAS
	Fast-SMS Service	USN-11	Use Fast SMS to send alert messages once the parameters like pH, Turbidity and temperature goes beyond the threshold	3	Medium	BARATH RAJ, CHANDRA MOHAN

## 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	04 Nov 2022
Sprint-2	20	6 Days	31 Oct 2022	05 Nov 2022	20	06 Nov 2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	20	13 Nov 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	20	19 Nov 2022

## 6.3 REPORTS FROM JIRA

The screenshot displays the Jira Software interface for a project named "Real Time River Water Quality Monitoring And Control System". The left sidebar shows navigation options: Planning (Roadmap), Development (Backlog, Board, Code), and Project (Issues, Add-on, Project settings). The main area shows the "Backlog" view with a search bar and a list of issues grouped by sprint.

**Sprint 1: 22 Oct - 29 Oct (3 issues)**

- RTWQMC5 1: As a user, I can register for the application by entering my email, password, and confirming my password. [REGISTERATION](#) (In Progress)
- RTWQMC6: As a user, I can register for the application through Gmail. [REGISTERATION](#) (Done)
- RTWQMC7: As a user, I can register for the application through email. [REGISTERATION](#) (In Progress)

**Sprint 2: 31 Oct - 7 Nov (3 issues)**

- RTWQMC8 2: As a user, I will receive confirmation email once I have registered for the application. [CONFIRMATION](#) (To Do)
- RTWQMC5 5: As a user, I can log into the application by entering email & password. [REGISTERATION](#) (To Do)
- RTWQMC8 8: To find and express the requirements to be needed in the code. [CODING](#) (To Do)

**Sprint 3: 7 Nov - 14 Nov (4 issues)**

- RTWQMC5 11: Get log on to the IBM Cloud Services. [CREATE IBM CLOUD](#) (To Do)
- RTWQMC5 12: To develop Node and service to integrate software process. [CREATE NODE RED SERVICE](#) (To Do)
- RTWQMC5 13: To create Web UI to access data from IBM Cloud database. [CREATE WEB UI](#) (To Do)
- RTWQMC5 14: Use MFT App Inventor to create app with respective requirements. [BUILD APPLICATION](#) (To Do)

**Sprint 4: 14 Nov - 19 Nov (3 issues)**

- RTWQMC5 19: Sending alerts when the respected measurements exceeds limits. [NOTIFY SMS SERVICE](#) (To Do)
- RTWQMC5 20: Publishing the data into cloud once sensed. [PUBLISH DATA TO CLOUD](#) (To Do)
- RTWQMC5 21: Testing of projects and analyze the result accuracy. [TESTING](#) (To Do)

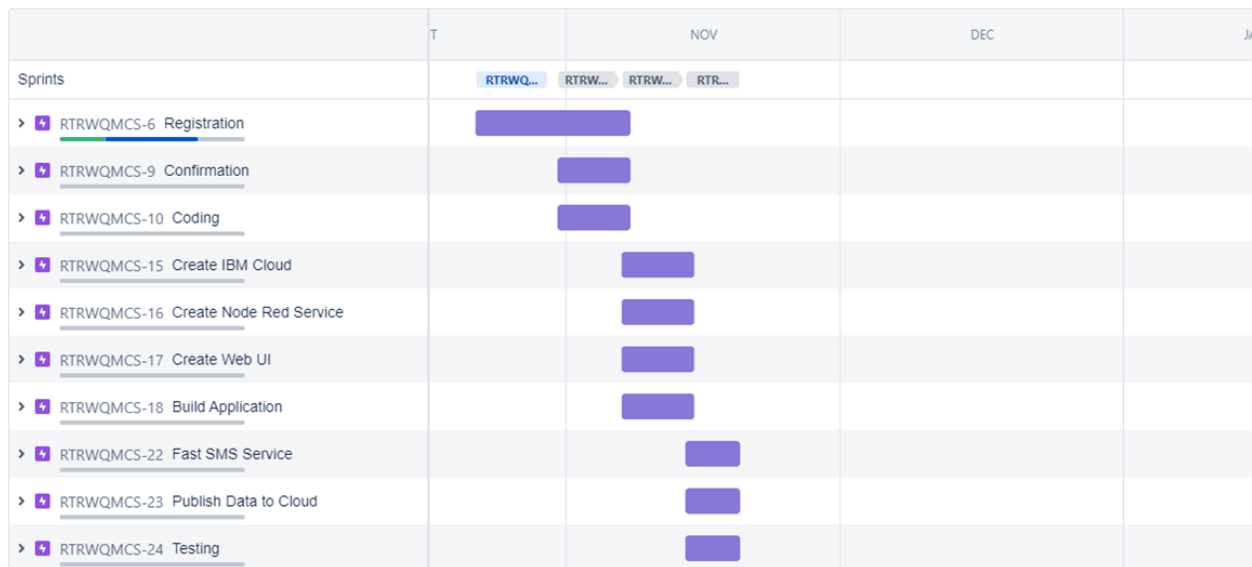
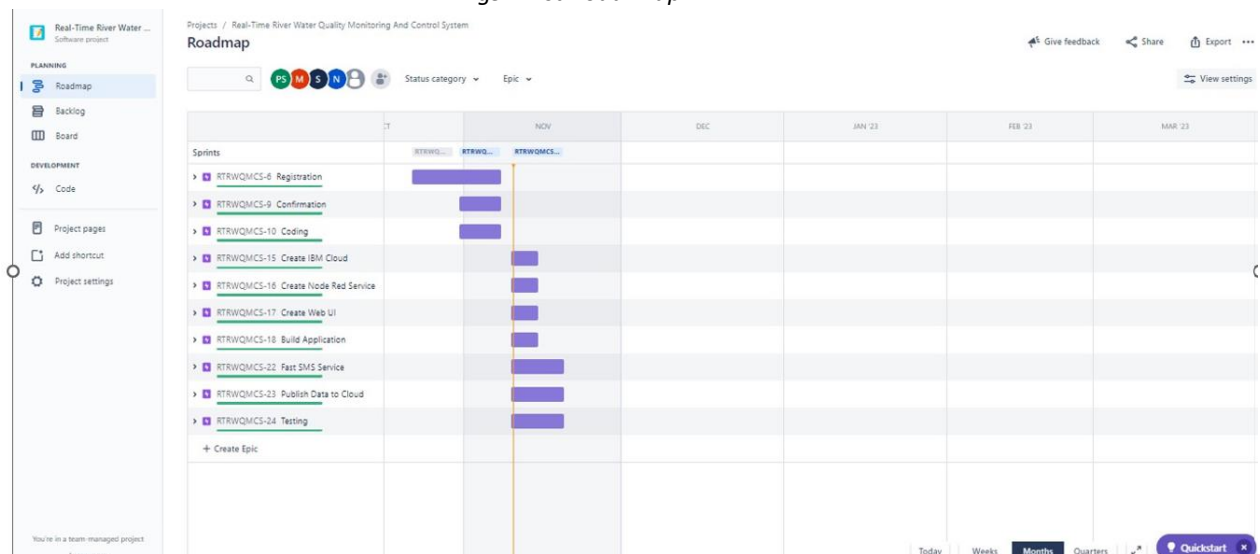


Fig9. First Road Map



## **CHAPTER 7 CODING & SOLUTIONING**

### **7.1 FEATURE 1**

#### **IBM WATSON IoT PLATFORM**

The very first process in this project section is to develop the IBM IoT Platform. This IoT platform is the core formula for all the connection process. As the only way of connecting several applications is the basic work of the cloud platform.

The process of signing in to the cloud process is the large process which carries verification segments too. After creating the Cloud Profile, lets move to device creation part.

#### **Device Creation**

Now the next step is to create a device, we have created a device with following details

Device Type : 1234

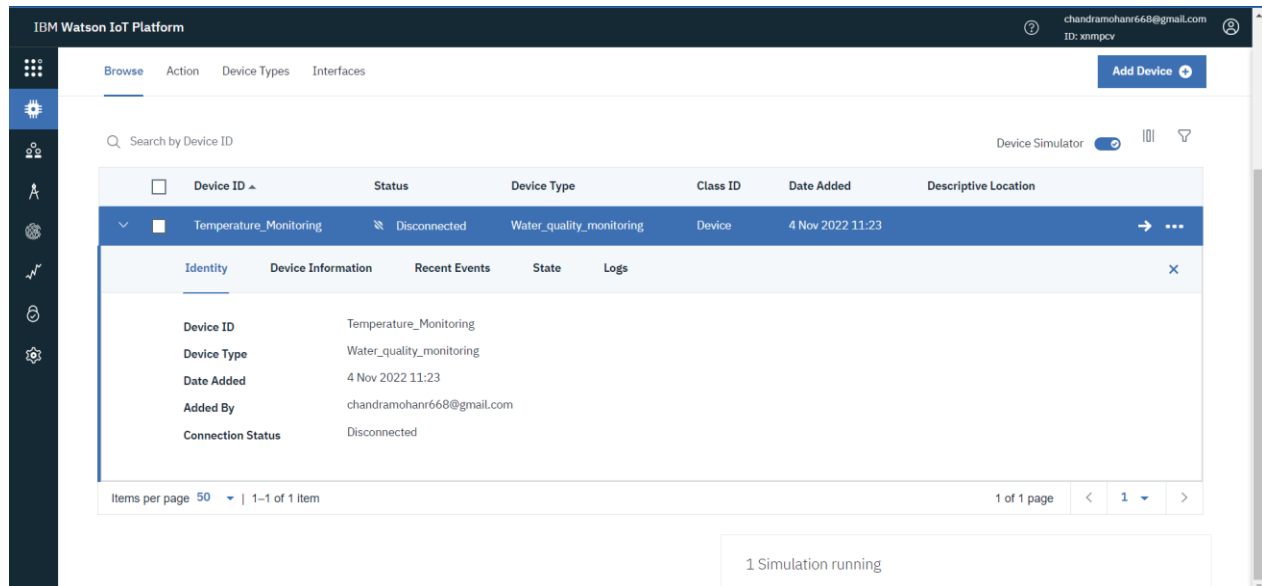
Device Id : 1234567

With following details, we have created a device and the code for this device carries the requirements which satisfies the project specification. We used temperature, humidity and the pH value in the code.

1. temperature - 0 to 100
2. humidity - 0 to 100
3. ph value - 0 to 14



While, the device is made to run the results are appeared in the Recent Events tab near the Device part.



*Fig11.Created Device*

## NODE-RED SERVICE

After registering to the IBM IoT Platform and created the device, now we move on to the Node-Red Service, in this here we can create the Web user interface and the Web Application by designing the circuit. Our Node-Red Circuit designing are as follows.

The first step is to install the IBM IoT block from the node-red service and we have set three functions namely, temp, hum, pH these three functions process temperature, humidity and the pH value. And the three functions are connected to the msg.payload button. At separately the functions are designed in the wave of chart, where temperature and humidity are designed in the Line Chart and pH value as Gauge chart.

After this, we set two buttons of the Switch board, Light ON and Light OFF. This button works as if it pressed to light ON, the python code displays "led is on", if light OFF, it shows "led is off".

Now for connecting to web we use "http" extension. And also, for connection to the Application we use MIT app application with get option function in Node-Red. The Node-Red website is copied and added "/sensor" to review the output.

For simulating the Node-Red Service, there appears "Deploy" button.

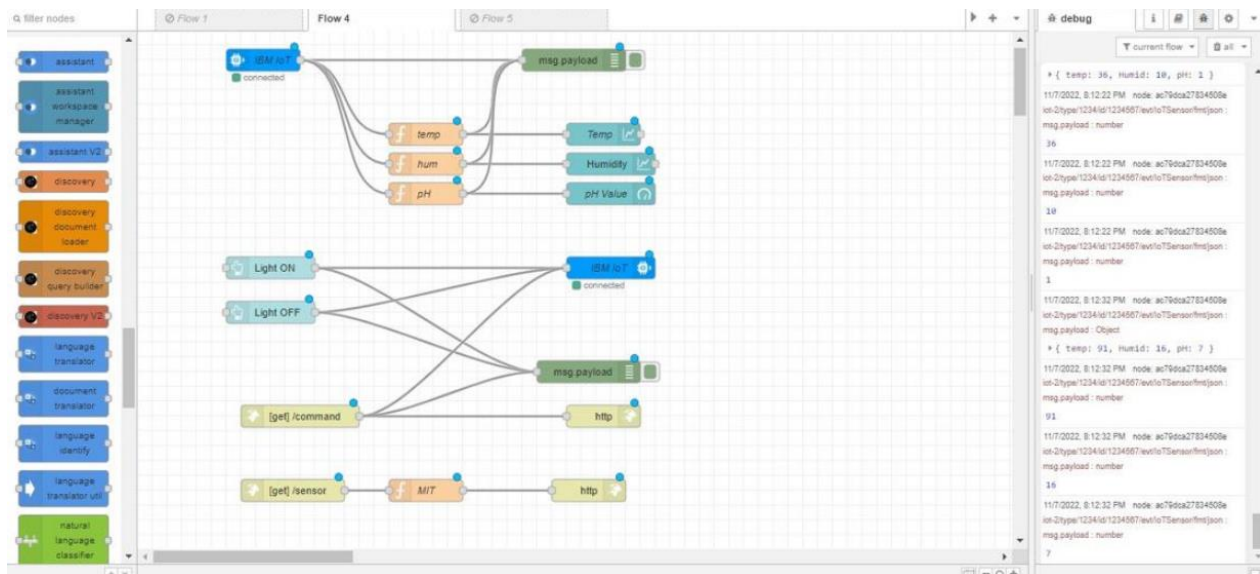
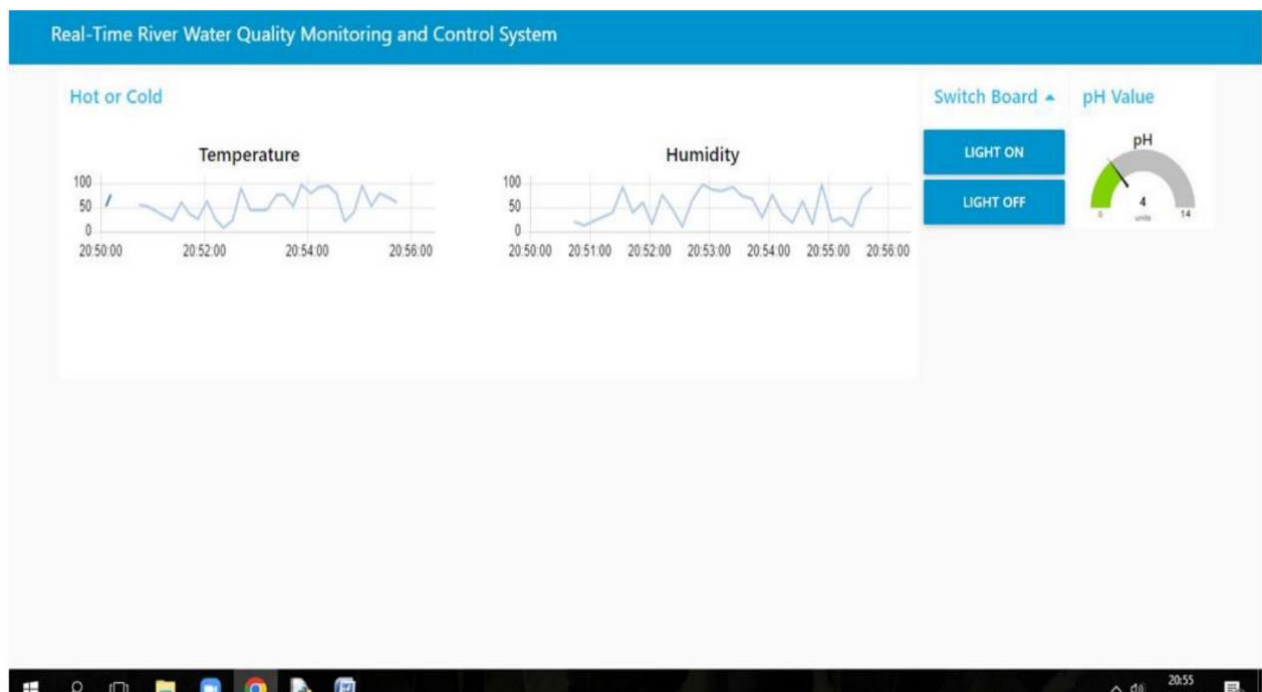


Fig12. Node-Red Circuit Design

## USER INTERFACE

After the successful simulation of the Node-Red Service, User Interface is created. Our Web UI includes Temperature, Humidity, pH Value in accordance with Switch Board of Light ON and Light OFF. The Temperature and Humidity varies from 0 to 100. And the pH varies from 0 to 14.

Our Executed User Interface from the Node-Red is shown below.



*Fig13.Node-Red Page Web User Interface*

**MIT APP INVENTOR**

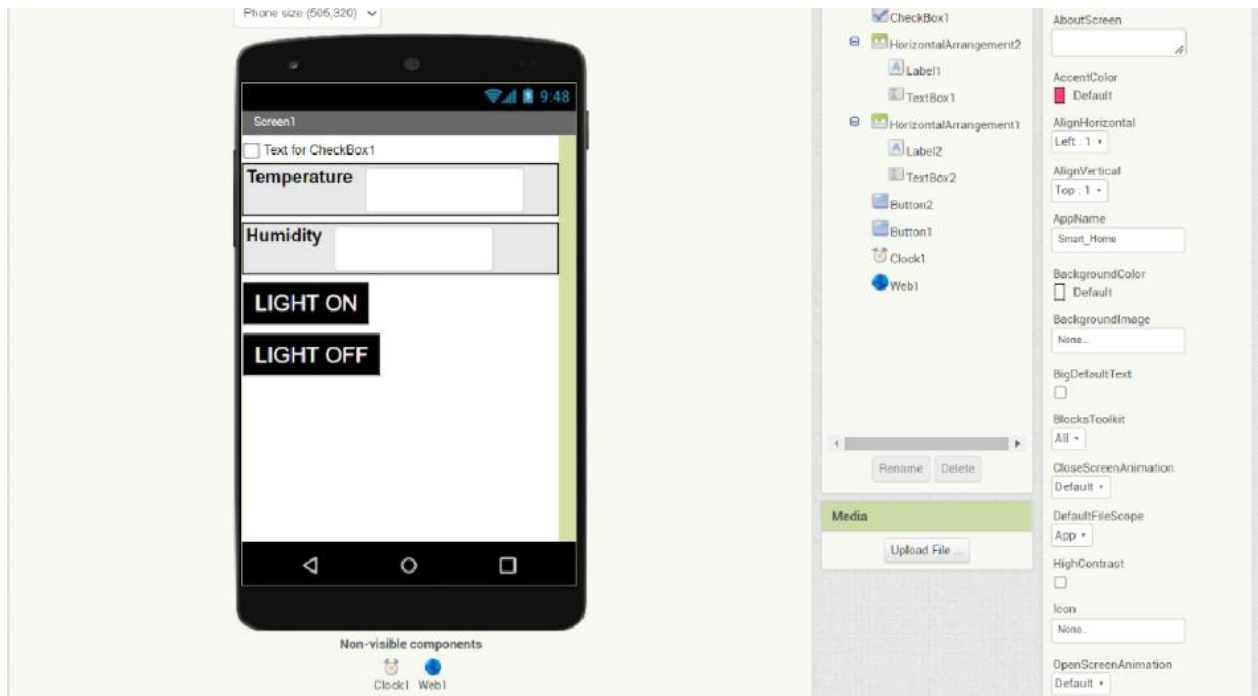
This phase is the most priority requirement of our project. Using an application helps users to monitor in easy way. MIT App inventor helps to design our application. We have created 6 Screens for our App.

The image shows a login screen with a dark gray background. At the top, there is a black rectangular button with the text "ENTER LOGIN CREDENTIALS" in white. Below this, there are two input fields. The first is labeled "USER ID:" and contains the placeholder text "enter user id". The second is labeled "PASSWORD:" and contains the placeholder text "enter password". Below the password field, there is a black rectangular button with the text "LOGIN" in white. At the bottom, there is another black rectangular button with the text "FORGOT PASSWORD" in white.

Following the Login Page, Selection of process is shown with three categories such as Temperature, Humidity and pH value and atlast Logout button.

When the category is selected the page moves on to the Output Display Page where we can see all the three results as the python code is made simulated.

The last page contains Switch board of Light ON and Light OFF. As same as user interface, here also when we press these buttons the output of led on or off is displayed in the Python code



## 7.2 FEATURE 2

### PYTHON CODE

Our Python Code is very Simple and easy to understand. The programs carries our device details and the requirements of the project are kept defined. All conditions are made properly and the output is done successfully.

#### CODE

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

```
#Provide your IBM Watson Device Credentials
```

```
organization = "udjkcs"
```

```
deviceType = "1234" deviceId
```

```
= "1234567" authMethod =
```

```
"token"
```

```
authToken = "123456789"
```

```
# Initialize GPIO
```

```
def myCommandCallback(cmd):
```

```
    print("Command received: %s" % cmd.data['command'])
```

```
    status=cmd.data['command']
```

```
    if status=="lighton":
```

```
        print ("led is on")
```

```
    elif status == "lightoff":
```

```
        print ("led is off")
```

```
    else :
```

```
        print ("please send proper command")
```

```
    #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)
    Humid=random.randint(0,100)
    pH=random.randint(0,14)

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

    success = deviceCli.publishEvent("IoTSensor", "json", data, qos=0,
on_publish=myOnPublishCallback)
    if not success:
        print("Not connected to IoT")
        time.sleep(10)

    deviceCli.commandCallback = myCommandCallback

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

```

## CHAPTER 8 TESTING

### 8.1 TEST CASES

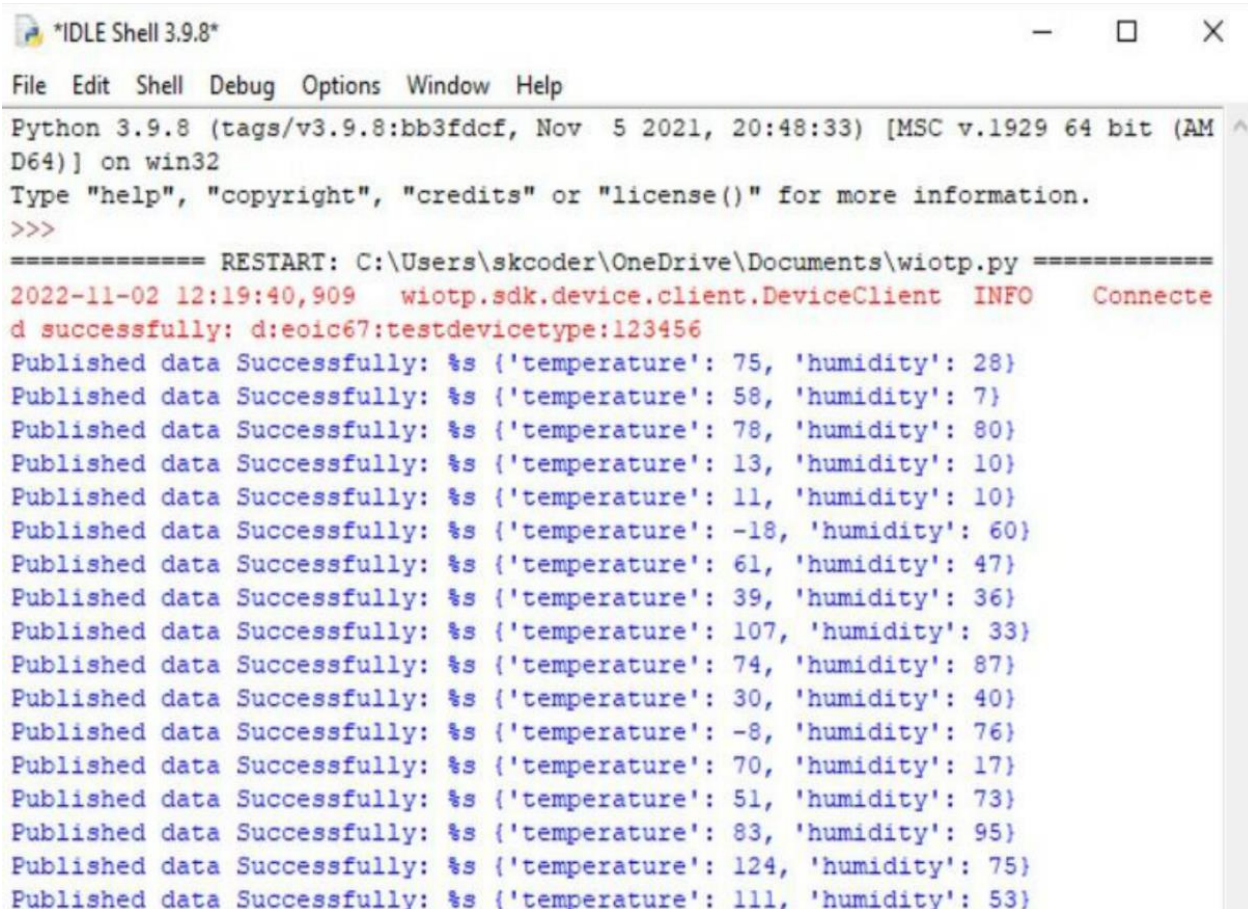
As the code is made to run, the system waits to connect with IoT platform. On account of connection with the IBM Watson Platform, the code displays the output with relevant details. The output is shown in Cloud platform, the links to Node-Red also to the UI section. Finally when the Application is operated, the output is also displayed in it.

In our python code, we used temperature, humidity and pH value with the following conditions temp=random.randint(0,100)

Humid=random.randint(0,100)

pH=random.randint(0,14)

The output of our Code is shown below,



```
*IDLE Shell 3.9.8*
File Edit Shell Debug Options Window Help
Python 3.9.8 (tags/v3.9.8:bb3fddf, Nov 5 2021, 20:48:33) [MSC v.1929 64 bit (AMD64)] on win32
Type "help", "copyright", "credits" or "license()" for more information.
>>>
===== RESTART: C:\Users\skcoder\OneDrive\Documents\wiotp.py =====
2022-11-02 12:19:40,909 wiotp.sdk.device.client.DeviceClient INFO Connected successfully: d:eoic67:testdevicetype:123456
Published data Successfully: %s {'temperature': 75, 'humidity': 28}
Published data Successfully: %s {'temperature': 58, 'humidity': 7}
Published data Successfully: %s {'temperature': 78, 'humidity': 80}
Published data Successfully: %s {'temperature': 13, 'humidity': 10}
Published data Successfully: %s {'temperature': 11, 'humidity': 10}
Published data Successfully: %s {'temperature': -18, 'humidity': 60}
Published data Successfully: %s {'temperature': 61, 'humidity': 47}
Published data Successfully: %s {'temperature': 39, 'humidity': 36}
Published data Successfully: %s {'temperature': 107, 'humidity': 33}
Published data Successfully: %s {'temperature': 74, 'humidity': 87}
Published data Successfully: %s {'temperature': 30, 'humidity': 40}
Published data Successfully: %s {'temperature': -8, 'humidity': 76}
Published data Successfully: %s {'temperature': 70, 'humidity': 17}
Published data Successfully: %s {'temperature': 51, 'humidity': 73}
Published data Successfully: %s {'temperature': 83, 'humidity': 95}
Published data Successfully: %s {'temperature': 124, 'humidity': 75}
Published data Successfully: %s {'temperature': 111, 'humidity': 53}
```

## 8.2 USER ACCEPTANCE TESTING

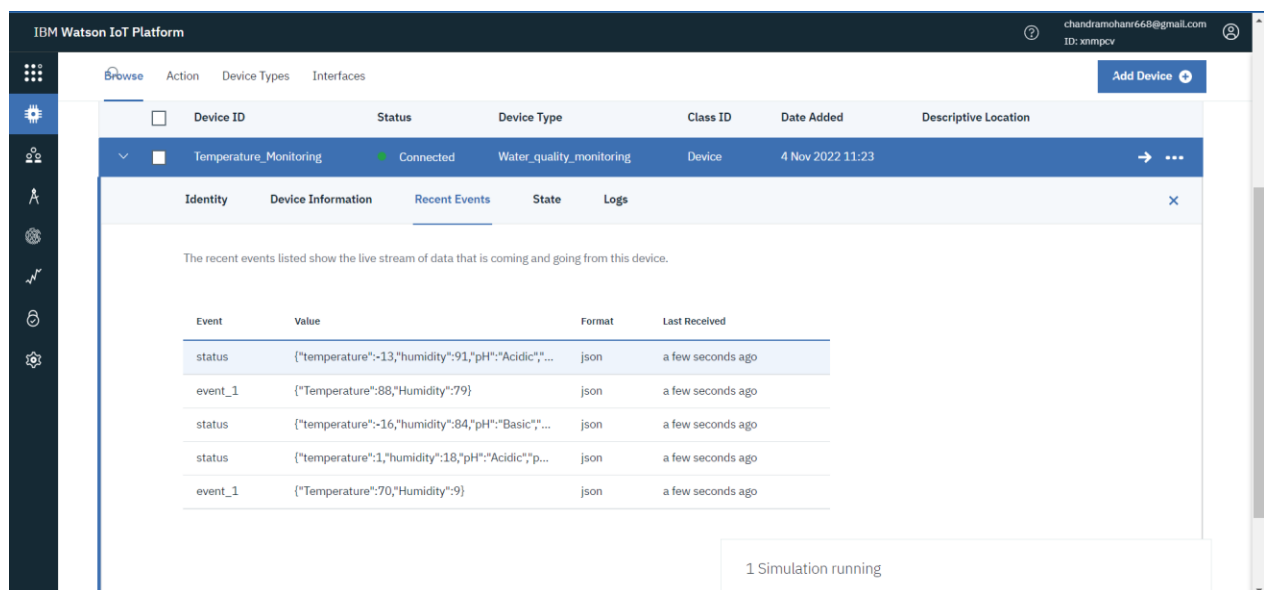
As the completion of the application development, the app should give as much support to the user. The developer must make sure of the avoidance of the disability in working of application by the user. All the appearance of the app should be able to be configurable to the user. The usage of the application must satisfy the user at 100%. All the specifications must be simple and easy to use.



## CHAPTER 9 RESULTS

### 9.1 PERFORMANCE METRICS

The performance and the working of the code is very quick and the results appear in quick succession. Our code is linked with the most used IBM Watson IoT Platform which works with much perfection. This cloud platform is very secure to use and configure easily. As the code is simulated within seconds the result appears. We have done a lot of work using this IoT platform which is very simple and good user friendly platform. Below we display our connected IoT platform which delivers the results as the code is run.



The screenshot shows the IBM Watson IoT Platform interface. The top navigation bar includes 'Browse', 'Action', 'Device Types', and 'Interfaces'. A user profile for 'chandramohan66@gmail.com' is visible in the top right. The main content area displays a list of devices. The selected device is 'Temperature\_Monitoring', which is 'Connected' and has a 'Device Type' of 'Water\_quality\_monitoring'. Below the device list, the 'Recent Events' tab is active, showing a table of events. The table has columns for 'Event', 'Value', 'Format', and 'Last Received'. The events include status updates and temperature/humidity readings. A status bar at the bottom indicates '1 Simulation running'.

Event	Value	Format	Last Received
status	{"temperature":-13,"humidity":91,"pH":"Acidic", ...	json	a few seconds ago
event_1	{"Temperature":88,"Humidity":79}	json	a few seconds ago
status	{"temperature":-16,"humidity":84,"pH":"Basic", ...	json	a few seconds ago
status	{"temperature":1,"humidity":18,"pH":"Acidic", ...	json	a few seconds ago
event_1	{"Temperature":70,"Humidity":9}	json	a few seconds ago

Fig18. IoT Platform Output

## CHAPTER 10 ADVANTAGES & DISADVANTAGES

## **ADVANTAGES**

Water quality standards also protect iconic, locally grown products such as wild rice and walleye. Protecting human health — Some pollutants pose risks to human health. Water quality standards protect human health and avoid the costs related to medical care, productivity loss, and even loss of life. This helps us to understand how the levels of nutrients, dissolved oxygen, temperature, salinity and phytoplankton change over time and how best to manage these conditions. Water quality is critical to environmental and ecosystem health. By monitoring water quality, researchers, scientists, and regulators can understand the impact of human activities, seasonal fluctuations, and weather events. Water quality data helps inform sustainable decision making and comprehensive regulatory policy.

## **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 does not reflect real time water quality measurement due to delay in measurement. Relationship and capacity challenges in water quality monitoring are discussed based on a rational approach to decision-making. Such an approach considers the costs and benefits of individuals and organisations in decision-making with regard to water quality monitoring. Both benefits and costs can be material (i.e. increase or decrease of financial resources) and immaterial (e.g. loss or gain of time, reputation).

## **CHAPTER 11**

## **CONCLUSION**

This way of monitoring the water quality made us very easy. Water monitoring is a crucial part of maintaining many environments including industrial buildings, commercial properties and healthcare establishments. Technology has advanced to the extent that there are now highly sophisticated, accurate and convenient water monitoring systems which offer a whole host of benefits. The major cause of water impurity by industrial wastes and also human acts. By analyzing the quality of water we can consume healthy state, but if we reduce the pollution causing acts we can gain more water ie.pure water even naturally. Stop polluting the river water and make environment clean and hygienic. Indicators are needed for monitoring the system from source to tap, including aesthetic changes, water quality indicators, suspicious activity, changes in water pressure and illness in the community. Action plans for management of both accidental and intentional pollution with biologicals and chemicals should include a base line understanding of the vulnerabilities and baseline quality. Triggers for action must be put in place: spill notification, rainfall, raw water turbidity, fecal indicators and public health indicators. The physical/chemical/biological and geological nature of the water system under study must be considered. Site assessment is an important component of the risk/management framework. Integration of inventory of risks to the watershed, along with climate prediction factors and the monitoring of the raw ambient water quality are critical. Monitoring recovery after contamination events is essential, this will require that baseline data sets are available. Climatic factors and meteorological data continue to show a pattern associated with water quality impacts ( during floods but even droughts) and are often associated with treatment and management failures. Thus meteorological data, weather forecasting, and climate prediction scenarios should be integrated in the development of any assessment and management strategy.

## **CHAPTER 12**

### **FUTURE SCOPE**

Environmental water quality monitoring aims to provide the data required for safeguarding the environment against adverse biological effects from multiple chemical

contamination arising from anthropogenic diffuse emissions and point sources. Current monitoring approaches tend to emphasize either targeted exposure or effect detection. Here, we argue that irrespective of the specific purpose, assessment of monitoring results would benefit substantially from obtaining and linking information on the occurrence of both chemicals and potentially adverse biological effects. As of now, water quality monitoring is just a wave of seeds. The development of this process must take advance at a quick rate. In the future, there will be a reduction in pollution as water quality monitoring grows.

## **CHAPTER 13**

### **APPENDIX**

#### **SOURCE CODE**

As we successfully developed and programmed our python code, lets this be the final code of execution.

```
import time  
import sys
```

```
import ibmiotf.application
import ibmiotf.device
import random
```

```
#Provide your IBM Watson Device Credentials
```

```
organization = "udjkcs"
deviceType = "1234" deviceId
= "1234567" authMethod =
"token"
authToken = "123456789"
```

```
# Initialize GPIO
```

```
def myCommandCallback(cmd):
    print("Command received: %s" % cmd.data['command'])
    status=cmd.data['command']
    if status=="lighton":
        print ("led is on")
    elif status == "lightoff":
        print ("led is off")
    else :
        print ("please send proper command")
```

```
#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)
    Humid=random.randint(0,100)
    pH=random.randint(0,14)

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

    success = deviceCli.publishEvent("IoTSensor", "json", data, qos=0,
on_publish=myOnPublishCallback)
    if not success:
        print("Not connected to IoT")
        time.sleep(10)

    deviceCli.commandCallback = myCommandCallback

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

```

## PROJECT DEMONSTRATION VIDEO

**GITHUB LINK :** <https://github.com/IBM-EPBL/IBM-Project-1883-1658419518>

**PROJECT DEMO LINK :** <https://youtu.be/CqL12GKSrTw>