A Project Report

on

An IOT based Real-Time Monitoring of Water Quality System

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CANDIDATE'S DECLARATION

I/We hereby certify that the work which is being presented in the project, entitled **"An IOT based Real-Time Monitoring of Water Quality System"** in partial fulfillment of the requirements for the award of the BACHELOR OF TECHNOLOGY IN COMPUTER SCIENCE AND TECHNOLOGY submitted in the School of Computing Science and Engineering of Galgotias University, Greater Noida, is an original work carried out during the period of JULY-2021 to DECEMBER-2021 under the supervision of Dr. B. Shajahan, Professor, Department of Computer Science and Engineering of School of Computing Science and Engineering, Galgotias University, Greater Noida.

The matter presented in the project has not been submitted by me/us for the award of any other degree of this or any other places.

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This is to certify that the above statement made by the candidates is correct to the best of my knowledge.

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CERTIFICATE

The Final Project Viva-Voce examination of AYUSH PATEL (19SCSE1010457), HARSHIT MISHRA (19SCSE1010099) has been held on _____ and his/her work is recommended for the award of BACHELOR OF TECHNOLOGY IN COMPUTER SCIENCE AND TECHNOLOGY.

Signature of Examiner(s) **Signature of Supervisor(s)**

Signature of Project Coordinator **Signature of Dean**

Date:

Place: Greater Noida

Abstract

With the emerging technologies and new generation, each field is developing gradually, like IoT, Artificial Intelligence, Big Data, Cloud Computing, etc. Currently, the Internet of Things (IoT) has become the pillar of all connected technologies, without which we can't imagine our single day. IoT is useful in every aspect of our life. Also, water is an essential component for all living beings, and monitoring of water quality and its parameter is a must to get safe water. The proposed model, water quality monitoring in Aquaculture based on IoT which is used to determine the different parameters of water like, pH value, turbidity, temperature, to detect the bad quality which may lead to any disease or adverse effect to a living being. So, it is crucial to detect the quality of water to have safe water for a healthy life. Traditional approaches include a manual collection of samples with complex methodology and ineffective because of time consuming, high cost, lack of real-time monitoring and testing is done later in the laboratory.

The presented paper is the evolution over the traditional approach which will determine the quality of water with aid of IoT in real-time. Internet of things is responsible for connecting various devices for sending and receiving data. The system used IoT that focuses on aquaculture species, and monitoring of water quality which helps the owner to determine the nature of water is good for the species or not. The system is like early detection of the quality and informs the owner to take required steps further. Different sensors are used to compute

The data and send it to the cloud. The system is based on the ThingSpeak platform which is an IoT platform service that provides analysis, storage, and visualization of the data in the cloud through MATLAB. Later IFTTT applets are used to send the notification to the owner.

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CHAPTER-1
INTRODUCTION

1.1. Introduction:

With rapidly rising population in India, Fresh Water Management is very much essential which demands an increase in agricultural, industrial and other requirements. The Quality of Fresh Water is characterized by "chemical, physical and biological" content. Monitoring the water quality helps in detecting the pollution in water, toxic chemical and contamination. The traditional method still in vogue entails collection of water samples, analyzing it in lab and advice for any water treatment and so forth. Current water pollution monitoring method takes place in 3 main steps :-

- Water sampling
- Testing samples
- Investigative analysis

All of these 3 steps are very expensive, difficult, time consuming, need expert advice and less efficient. So with the advent of technology, automation can be brought in water quality monitoring in taking action appropriately rather than relying on manual process.

So in automating the water quality monitoring some amount of technological innovation has creeped in which would help in monitoring the quality of water rather than relying on manual process.

In one of the system, Eco Mapper which is an autonomous underwater vehicle been employed which helps in mapping the quality of water, currents of water and so. Drawback of the system is that it has 8-14 hour life span at the speed of 2-4 knots. This method involves human need and risk of human health underwater in a contaminated environment is very high.

In one another research, robotic fish is employed where oxygen levels in water can be measured. The control centre captures the data transmitted wirelessly for

analysis. The main drawback of this system is battery depletion of robotic fish system leading to abrupt ceasing of fish while monitoring the water quality.

Also research been done by employing digital camera underwater in monitoring the movement of the protozoa which is placed in sampling water. Biological and Chemical pollution can be detected by employing robotic fish methodology. The major drawback in this method is its inability to identify the pollutant until further analysis.

Research also has been done in algae detection by employing. shining laser beam into algae which determine the amount of contamination from the sound waves emitted under the water. Different sound waves are emitted based on different kinds of pollution affecting the algae.

This method is limited to algae detection only and not finding other physical and chemical properties of water.

In addition to monitoring the water quality using Technology, there has also been some limited amount of research been carried out in employing Machine learning technique in Water Quality Monitoring.

Machine Learning is a branch of Artificial Intelligence (AI) which allows devices to learn without being explicitly programmed. One of the research been reported employing Machine Learning in Water Quality Monitoring in rivers which is based on Least Squares Vector Machine.

So with the upcoming of Machine to Machine communication leading to Internet of things which involves devices interacting among themselves without any human intervention, we here have developed an Intelligent IoT based Water Quality Monitoring system where PH sensor and TDS meter deployed for collecting the water parameters periodically from different types of water. These collected water parameters are sent to the microcontroller and same sent by means of serial communication to Raspberry Pi3. The Pi3 processor got the K-Means clustering algorithm in grouping the water parameters into different clusters based on PH and TDS and accordingly train the data set for predicting the quality of water as good or bad. This information is updated in webpage of cloud for water authorities to take action. This is been developed as a prototype using Arduino and Pi3.

With the development of aquaculture industry, feature and quality of water like pH, temperature, turbidity is becoming a most important factor to be measured. Water temperature is responsible for the feeding time and growth of fish. The quantity of dissolved oxygen is less in warm water than in cold water. Aquarium tanks need to be set up and maintained properly. The aquatic plants and animals present in the planted tank need to be taken care of. Their life may become short due to less water in the tank. The level of sunlight and carbon dioxide need to maintain for the proper growth of plants and fish. That's why it is crucial to observe the condition of water closely and properly.

A. Disadvantage of Traditional approach
   - Collect sample manually.
   - Complicated methodology.
   - Time consuming.
   - Low measurement precision.
   - High cost.
   - Lack of real-time monitoring

B. Advantage of Proposed system
   - No need for manual collection
   - Ease of use
   - Cheap and quick process

1.2. INTERNET OF THINGS (IoT):

The Internet of Things (IoT) is a large network that connects different objects over the internet. It refers to a system of interconnected objects that are connected to collect and transfer data over the internet without human need. IoT can build a system which is automatic, efficient, effective and essential for all human being. IoT comprises lots of applications, it includes innovative shopping, system infrastructure management, remote health monitoring, emergency notification system.

The Internet of Things (IoT) is a communication model of present-time which connects different objects like microcontroller, digital transmitter, receiver over the internet for communication purposes and perform various functions. The main aim of IoT to make the internet famous for easy interlinkage with a large number of devices like home automation, surveillance devices, engine, vehicles, etc. due to the tremendous increase in the IoT, many other platforms also connect with a heterogenous object over the internet.

1.2.1. Characteristics of IoT system:

1. IoT system consists of a central object which has unique identification to be easily distinguished from the other objectives of the network.

2. The object of the IoT system should be able to detect the existence of other objects that appears in the network.

3. The object of IoT (sensor) should able to capture the data automatically.

4. The object must be interpretational within different communication technologies.

5. There should be service-based interaction between objects. IoT systems should have low power operations and they should be secure.

CHAPTER-2

LITERATURE SURVEY

2.1. Literature survey:

Literature review is the study to be done to gain knowledge and skill needed to complete the survey. This is done to get help in the completion of a project. It is a survey on the previously existing material on the topic of our interest. The main aim of the literature review to develop and improve a successful project.

Some of the previously published paper which are studied for implementation of the system are mentioned below:

[1] Kalpana, M. B., and M. Tech Student. "Online monitoring of water quality using raspberry Pi3 model B." The main aim of the proposed paper is to automatically monitor the quality of water. The model is used to calculate the input value and update the data into the server without the work done by a human. The system is based on raspberry Pi3 model B to get the data from different sensors used in the project over the internet. The model is efficient, convenient, and fast for monitoring the water. The system is flexible for any sensor used in the system and coding is done in python programming. The system can be used in various applications and with extension value. It can be used to monitor other values like hydrologic, air pollution, industrial and agricultural production, and so on.

[2] Chandanapalli, Suresh Babu, E. Sreenivasa Reddy, and D. Rajya Lakshmi. "Design and deployment of aqua monitoring system using wireless sensor networks and IAR-Kick." The system is based on hardware components and forms a wireless sensor network for aquaculture monitoring, with different sensors and transmitter/ receiver and contain software design. The system contains two models that are transmitter station and a second is receiver station. The transmitter station contains all the sensors, microcontroller, and GSM, analog/ digital converter. The receiver station contains a GSM module which is used for receiving the data capture by the

sensor through the transmitter in the GSM network. The receiver station is used to receive the data and store it into the database for further calculation and observation. Visualization and analysis of data are done then the notification is sent to the farmer on mobile phone and alerts them when changes occur in environmental condition.

[3] Daigavane, Vaishnavi V., and M. A. Gaikwad. "Water quality monitoring system based on IoT." The system is based on IoT and is low-cost real-time monitoring of water. The system consists of various sensors to calculate the required value for monitoring the nature of water and connected to Arduino. The sensor data is viewed on a wi-fi system over the internet. Later, the data is sent to the BLYNK app for visualization, and data is shown through different widgets and an alert message is sent to the owner.

[4] Kaimal A, Jaison R, Santha V, Anand S, "Smart Aquarium". The project deals with the monitoring of pH, level of water, temperature, and feeding the fish of the aquarium. The system is made of PLC (Programmable Logic Controller) and SCADA (Supervisory Control and Data Acquisition) for the automatic control and monitoring of different parameters of the aquarium. The project can be implemented further to be used on large scale. This smart aquarium will save time and the owner need not to worried when he is not home. As PLC is used as the controller, different aquariums can be connected and used using a single PLC.

[5] Mohd Saad Hamid, Muhammad Amirul Abd Wahab, Rasyidah Abdullah, "Development of Water Quality Monitoring for Smart Aquaculture System", project mainly focuses on local aquaculture species and allow the fish farmer to monitor the water quality and condition of fish. The system is build using Raspberry pi with different sensors for monitoring the relevant values for monitoring the water quality. The system is used for early detection as connected to the BLYNK cloud for sending and storage of data. The visualization of calculated data is done in the BLYNK platform, as it provides its server and cloud for storage, and notification is sent to the farmer when some changes occur like water.

[6] Pasika, Sathish, and Sai Teja Gandla. "Smart water quality monitoring system with cost-effective using IoT", discussed the design of a system that is efficient, cost-effective, can work in real-time. The main aim of the system is to find the drinking water is safe for health or not through water quality monitoring with the help of the Internet of Things. In this model microcontroller unit (MCU) is used to connect the required sensor for monitoring the nature of water and further processing is done in a web app. ThingSpeak platform is used for the analysis and visualization of data. The platform provides its server and cloud for storage of data and have lots of functionalities and graphically show the result through MATLAB programming and sent the data over the IoT.

[7] Miry, Abbas Hussien, and Gregor Alexander Aramice. "Water monitoring and analytic based ThingSpeak." The main aim of the proposed system is to convey the advantages of real-time monitoring over the traditional method of water quality. The system is built on IoT over the internet to monitor the quality of water for different places. The system uses a hardware component and is programmed in Arduino IDE and used ThingSpeak platform for observation and visualization of data. The ThingSpeak platform will provide a ThingSpeak server and cloud which is used for storage and analysis of data. The calculated values can be observed using the web application and mobile application of the ThingSpeak platform, and an alert message is sent to notify about the condition of the water. The proposed model can also use in other fields like healthcare etc.

[8] Junaid Khan, Onib-Ur-Rehman, Zafran Jalil1, Sikandar Ali, Abdul Samad Danish, “Implementation of Smart Aquarium System Supporting Remote Monitoring and Controlling of Functions using Internet of Things”. the system discussed the fully automated and remote monitoring of the aquarium. An important feature of the project includes mechanical design of fish feeding system, real-time monitoring of the feeding, observation of other parameters like pH value, temperature, turbidity, the water level of the aquarium. The results can be observer through the web app or mobile app on a smartphone. The system is build using Node MCU v1.0, Cayenne, and Arduino mega 2560 for sending the data over the IoT with the aid of the internet. The system is designed to automatically take care

of the fish and to remotely control the device over the cloud. The system design a new mechanical fish feeder which is efficient and saves time for humans and can automatically take care of the Asian Journal of Convergence in Technology ISSN NO: 2350-1146 I.F-5.11 Volume VII and Issue II 45 fish and real-time monitoring is done, also cost-effective and easy to use.

[9] Nikhil Kedia entitled "Water Quality Monitoring for Rural Areas-A Sensor Cloud Based Economical Project." Published in 2015 1st International Conference on Next Generation Computing Technologies (NGCT-2015) Dehradun, India. This paper highlights theentire water quality monitoring methods, sensors, embedded design, and information dissipation procedure, role of government, network operator and villagers in ensuring proper information dissipation. It also explores the Sensor Cloud domain. While automatically improving the water quality is not feasible at this point, efficient use of technology and economic practices can help improve water quality and awareness among people.

[10] Jayti Bhatt,Jignesh Patoliya entitled "Real Time Water Quality Monitoring System".This paper describes 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. In this paper, we present the design of IOT based water quality monitoring system that monitor the quality of water in real time. 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 this processed values are transmitted remotely to the core controller that is raspberry pi using Zigbee protocol. Finally, sensors data can view on internet browser application using cloud computing.

2.2. Hardware component:

A. pH sensor-

In chemistry, pH is known as ‘potential of hydrogen’ or ‘power of hydrogen’. It is a scale that is used to specify whether the solution is acidic or basic. A pH scale is logarithmic and the concentration of hydrogen ions in a Asian Journal of Convergence in Technology ISSN NO: 2350-1146 I.F-5.11 Volume VII and Issue II 46 solution. The pH ranges from 0 to 14. There are three types of solution present in nature, at 250 C if the pH of the solution is less than 7 then the solution is ‘acidic’ and greater than that are basic. Solution of pH equal to 7 is known as neutral. The pH ranges from 6.5 to 9.5 are safe for drinking and also healthy for aquatic species. So, a pH sensor, fig 1. is used to measure the pH value of water in the planted tank to get detailed information about the quality and feature of water and to decide whether is safe or not and when the values exceed the threshold there is a need to change the water of the tank.

Fig.1, pH sensor

B. Turbidity sensor-

The Turbidity sensor, fig 2. measures the water clearness, i.e., the total number of particles suspended on the water. A turbidity sensor is used to compute the quantity of light that is disintegrated by the suspended solids in water and calculate the

number of water particles floating in the water. Exceeds in turbidity may harm the aquatic species and cause illness to fishes. As the amount of total suspended solids (TSS) in water increases, the turbidity level of water also increases. The turbidity sensor measures the changes in the water quality and shows the results, if the range exceeds the safe level the water needs to be the change of healthy life of aquatic species in the planted tank.

Fig.2., Turbidity Sensor

C. Temperature Sensor-

A Temperature sensor, fig 3. is used to detect the temperature of water i.e.; water is hot or cold. The range of the DS18B20 temperature sensor is -55 to +125 °C. This temperature sensor gives accurate reading as it is a digital type sensor. DTH-11 sensor is also used to measure the temperature and humidity of the atmosphere. This sensor has a negative temperature coefficient (NTC) component for measurement of temperature, and it is connected to a high high-performance 8-bit microcontroller, which provides excellent quality, fast response, anti-interference ability, and cost-effectiveness. This sensor is used to measure the temperature of the surroundings and to check that the pH and turbidity sensors are worked correctly over a long time.

Fig.3., Temperature Sensor

D. NodeMCU-

Node Micro Controller Unit (NodeMCU), fig 4. is an open-source IoT platform. NodeMCU runs on ESP8266 Wi-Fi SoC. It is a Wi-Fi module that is used to connecting all the sensors with the IoT. It is a hardware and software developing environment. Coding of the NodeMCU is done in Arduino IDE after setting up the required board and ports. Power is supply through USB cable. NodeMCU comes with multiple ports, feature, and specification.

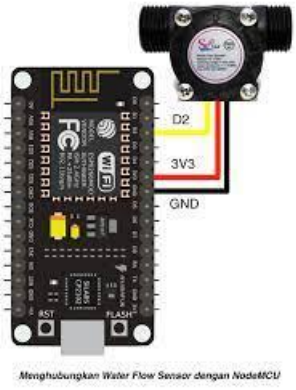

Fig.4., NodeMCU

2.3. Software Component:

A. Arduino IDE-

The Arduino Integrated Development Environment (IDE) is multiple computing platforms and works for Windows, Mac OS, Linux. This platform allow us to do programming for all the sensors of the area of interest of the project and uploading it to the microcontroller used. The Arduino IDE supports Embedded C for coding for all the hardware equipment and uses the special rule of code structuring. Arduino IDE supplies in-build program for different micro-controller and supplies software library from the wiring project, provide input and output procedures.

B. ThingSpeak Server-

ThingSpeak is an open-source Internet of Things (IoT) analytics platform that provides various functionalities like, aggregate, and analyse live data steam, storage of data in the cloud, and visualization of data through MATLAB programming. ThingSpeak server, fig 5., main functionality is to collect the input data measure by the sensors and upload the data privately into the cloud. After that analyse and visualize your data with MATLAB, and graphically show the result. We can also add different widgets of our interest and perform different tasks in it by adding react and action, then the server will trigger a reaction.

ThingSpeak Features -

- Collect data in private channels
- Share data with public channels Asian Journal of Convergence in Technology ISSN NO: 2350-1146 I.F-5.11 Volume VII and Issue II 47
- RESTful and MQTT APIs
- MATLAB analytics and visualizations
- Event scheduling
- Alerts
- App integrations

Works With

- MATLAB
- Arduino
- Particle Photon and Electron
- ESP8266 Wi-Fi Module
- Raspberry Pi
- LoRaWAN
- Things Network
- Senet
- Libelium
- Beckhoff

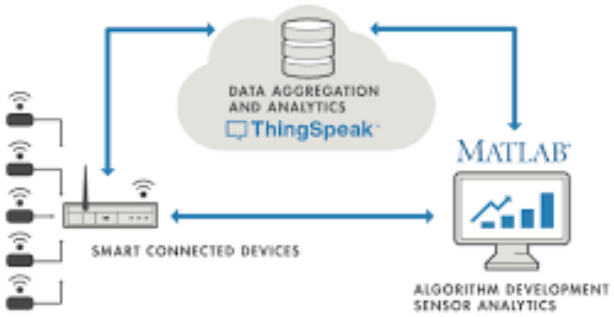

Fig 5., ThingSpeak Server

C. IFTTT applets-

If this then that commonly known as IFTTT, fig.6., is a service that is used to program various responses for events of different kinds. Multiple events are present to which IFTTT can respond via the internet. IFTTT is used to send the notification if the threshold meets. Webhooks is one of the functionalities of IFTTT which is used for automatic calls to a server. If the specific event happens then that call will

trigger. IFTTT is a cloud application in which webhook is a method in web development that is responsible for changing the behavior of the web pages and web application. Webhooks are user-defined HTTP callbacks. They are usually triggered by some event, such as when the value meets the threshold, or a comment is posted on a blog, or any spam detected, etc. When the event occurs, the source site makes an HTTP request to the URL for the webhook. Users can arrange them to form events on one site to cite behavior on another side. Webhooks use HTTP, which can be integrated into web services without adding new infrastructure. architecture which is responsible for storage, analysis, visualization of the data. The application layer is responsible for conveying various services to the user. It provides lots of features that have great importance in the Internet of Things for connecting various objects.

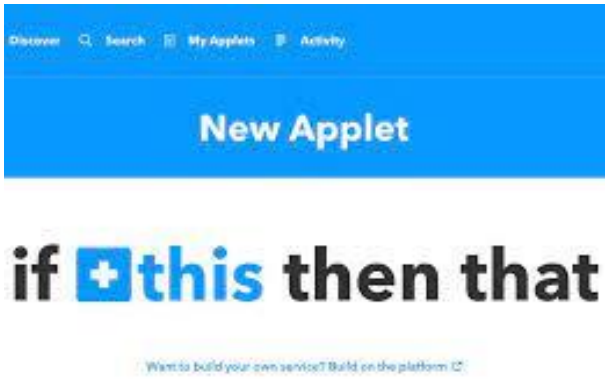

Fig.6., IFTTT applets

CHAPTER-3

WORKING OF PROJECT

The proposed paradigm is a hardware and software-based embedded system. Because an embedded system is based on a microprocessor, it is a blend of hardware and software programming. For building an advanced and effective water quality monitoring system, the system is built on IoT (Internet of Things). The system consists of the necessary sensors for gathering environmental data and delivering it to a higher layer for data observation and transmission to the ThingSpeak server.

The embedded system, which contains NodeMCU as a Wi-Fi module, is the most important part of the system. The system's core component, responsible for connecting all of the hardware components to the software. A 3.3v/5v power supply is utilised to power the Wi-Fi module. We are employing a total of three sensors to capture the essential critical data, such as a pH sensor, a temperature sensor, and a turbidity sensor. Each sensor can function on a 3.3v/5v power source and has an input pin and ground pin that are connected to the ground pin and analogue pin of the NodeMCU. After the sensors are connected, they begin gathering data and sending it to be visualised, shown in Figure 7.

After setting up the appropriate board and ports, the sensors and NodeMCU are coded in the Arduino IDE. The coding is done in an embedded C language that is simple to learn and utilise. The ThingSpeak platform will be used to visualise the results, as a new channel will be formed and all of the widgets will be set up according to the needs, and an API key will be provided to link the ThingSpeak to the NodeMCU. All we have to do now is create the code for all of the sensors in the Arduino IDE, connect the code to the ThingSpeak server by include the API key in the code, and upload it. ThingSpeak will display the output as results, which

is collected as input data via sensors. IFTTT applets are utilised in the later portion to deliver notifications when the sensor detects changes in the environment.

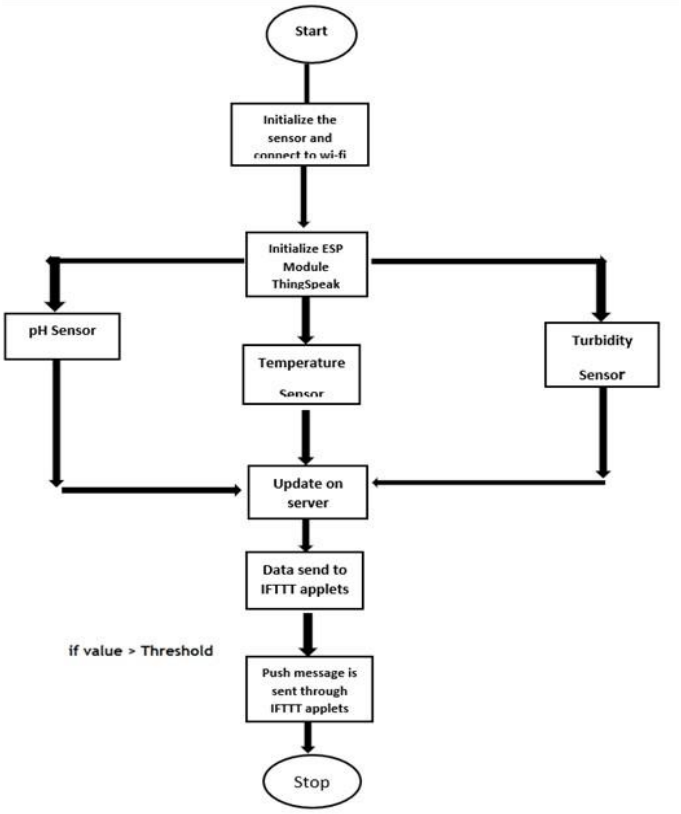

Fig. 7. Algorithm for the proposed system.

CHAPTER-4

RESULTS AND DISCUSSION

The resulting detected pH, temperature, turbidity, and ORP values are shown in Figure 8 (a). It continually monitors pH, temperature, turbidity, and ORP, and displays the results on an LCD, PC, or mobile device in real time. The obtained value will be shown as 'BAD' if it exceeds the threshold value. Comments will be presented as 'GOOD' if the acquired value is less than the threshold value. For a better understanding, a bar/line graph will be provided. Figure 8 shows a time series display of sensor data with a choice.

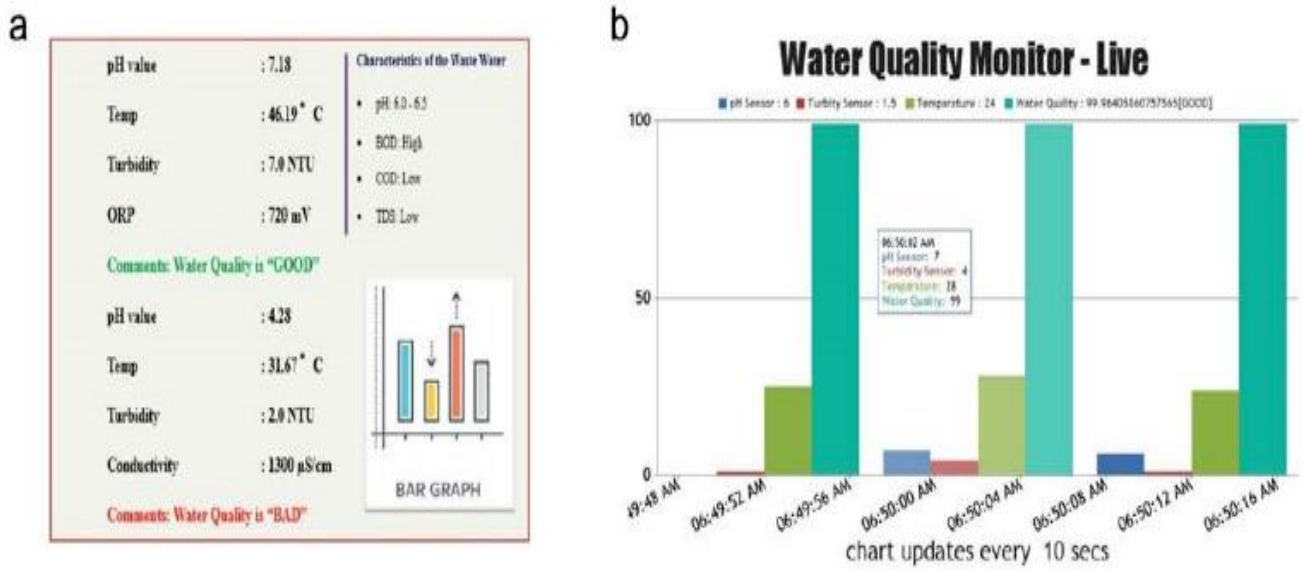

Figure 8. (a) The pH, temperature, turbidity, and ORP values sensed as a result are shown in the figure. It continually monitors pH, temperature, turbidity, and ORP, and displays the results on an LCD, PC, or mobile device in real time. The obtained value will be shown as 'BAD' if it exceeds the threshold value. Comments will be presented as 'GOOD' if the acquired value is less than the threshold value. For a better understanding, a bar/line graph will be provided. (b) A decision-making time series representation of sensor data.

CHAPTER-5

CONCLUSION AND FUTURE SCOPE

5.1 Conclusion

The major goal of the proposed system is to use smart water quality monitoring in a planted tank. This device will continuously monitor the quality and characteristics of water. Water quality monitoring is essential for aquatic plants and animals to live in a healthy and safe environment. The system described in this study is a low-cost, high-efficiency model for real-time water monitoring. The web application ThingSpeak is used to monitor and visualise the findings derived by the various sensors in the system and submit them to the ThingSpeak server. In addition, the value can be tracked via the ThingSpeak smartphone app.

Later on, IFTTT applets appear, which make use of ThingSpeak's services such as ThingHTTP and ThingSpeak Reacts. Because the ThingSpeak service employs IFTTT applet URLs, it will alert the owner when the calculated values exceed the threshold.

5.2 Future Scope:

- In the future, we will employ the Internet of Things (IoT) idea in this project
- Detect more parameters for the most secure purpose.
- Adding extra sensors to the equation will increase the parameters.
- We regulate the water supply via interfacing relays.

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