DAYANANDA SAGAR UNIVERSITY

KUDLU GATE, BANGALORE – 560068

Bachelor of Technology
in
COMPUTER SCIENCE AND ENGINEERING

Major Project Phase-II Report

Design and Implementation Water Quality Monitoring System for Aquaculture using IOT and Evaluation Using ML

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(2022-2023)

DAYANANDA SAGAR UNIVERSITY

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CERTIFICATE

This is to certify that the Major Project Stage-2 work titled **"Design and Implementation Water Quality Monitoring System for Aquaculture using IOT and Evaluation Using ML"** is carried out by **Hemanth Kumar S (ENG19CS0120), Hithesh Kumar N (ENG19CS0121), K.Vilohit (ENG19CS0135), Kushal A (ENG19CS0151)** a bonafide students of Bachelor of Technology in Computer Science and Engineering at the School of Engineering, Dayananda Sagar University, Bangalore in partial fulfilment for the award of degree in Bachelor of Technology in Computer Science and Engineering, during the year **2022-2023**.

Prof. Shwetha G.S	**Dr. Girisha G S**	**Dr. Udaya Kumar Reddy K R**
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Date:	Date:	Date:

Name of the Examiner **Signature of Examiner**

1.

2.

DECLARATION

We, **Hemanth Kumar S (ENG19CS0120), Hithesh Kumar N (ENG19CS0121), K.Vilohit (ENG19CS0135), Kushal A (ENG19CS0151),** are students of Eighth semester B. Tech in **Computer Science and Engineering**, at School of Engineering, **Dayananda Sagar University**, hereby declare that the Major Project Stage-2 titled **"Design and Implementation Water Quality Monitoring System for Aquaculture using IOT and Evaluation Using ML"** has been carried out by us and submitted in partial fulfilment for the award of degree in **Bachelor of Technology in Computer Science and Engineering** during the academic year **2022-2023**.

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We would like to thank our guide ***Prof. Shwetha G.S** , **Assistant Professor**, **Dept. of Computer Science and Engineering**, **Dayananda Sagar University**, for sparing her valuable time to extend help in every step of our project work, which paved the way for smooth progress and fruitful culmination of the project.*

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TABLE OF CONTENTS

NOMENCLATURE USED

IOT	Internet OF Things
PH Sensor	Potential Hydrogen Sensor
GUI	Graphical User Interface
ML	Machine Learning
HTTP	Hypertext Transfer Protocol
NTU	Nephelometric Turbidity Unit
BNC	Bayonet Neill Concelman Connector
Wi-Fi	Wireless Fidelity

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

Water pollution is one of the biggest threats for the aquatic ecosystem. Water pollution affects the health of people by causing waterborne diseases. To prevent the water pollution, necessary steps are to be taken. First step is to estimate the water parameters like pH, turbidity, conductivity etc**.**

There has been an increase in the demand for dietary fish protein globally. This has resulted in overfishing in natural fisheries. To avoid complete depletion, fish farming / pisciculture is widely practiced across the world. Pisciculture involves breeding of fishes in artificial enclosures like ponds, tanks etc. It is a controlled cultivation where a pseudo natural environment has to be created to breed the fishes. Hence maintaining the water qualities like temperature, PH level, salinity, turbidity is of high importance.

In this report, the design of Arduino based water quality monitoring system that monitors the quality of water in real time is presented. This system consists of different sensors which measures the water quality parameter such as pH, temperature, muddiness of water and depth of the water. The measured values from the sensors are processed by microcontroller and the processed values are transmitted to the email account of the concerned authority**.** The purpose of the study of this project is design and implement a water quality monitoring and notification system for fish farmers to determine the physio- chemical parameters of aqua-cultured sites such as fish ponds.

CHAPTER 1

INTRODUCTION

CHAPTER 1 INTRODUCTION

Environment around us consists of five key elements. These are soil, water, climate, natural vegetation and land forms. Among these waters is the most essential element for humans to live and is the most abundant liquid on earth. It covers more than 70 percent of the earth's surface. It is also important for the survival of other living habitants. Whether it is used for drinking, domestic use, and food production or recreational purposes, safe and readily available water is must for public health.

So, it is highly imperative for us to maintain water quality balance. In the course of recent decades, fish ponds in and around have slowly capitulated to a reasonable level of Pollution. Using of chemical fertilizers and dumping of contaminants into ponds are the real essential types of fish pond pollution. It is a need to check the water of fish ponds regularly utilizing agile technologies. Wiping out water pollution in fish ponds inside and out may appear as though an incredible idea however restricting its belongings when it happens is absolutely conceivable. The essential goal of this project is to devise a strategy to screen the quality of fish pond water with an end goal to help in water pollution control with the assistance of IoT. This project will monitor the quality of water, in terms of monitoring the level of water, the temperature of the water and its surrounding, the turbidity of the water (how clean the water is) as well as the PH levels of the water. So, this system monitors all of these aspects and finally when all checks have been completed, it sends the data as an email to notify the authorized personnel.

1.1. EVOLUTION OF INTERNET OF THINGS

The internet of Things (IoT) is a revolutionary new concept that has the potential to turn virtually anything “smart". A Thing in this context could be defined as an object such as a cardiac monitor to a temperature sensor. This extraordinary event has captured the attention of millions. Why is this so big today? Imagine a world where machines function without any notion of human interaction.

A future where machines communicate with other machines and make decisions based on the data collected and all independent of an end user. IoT is determined as the network of environmental objects or items which includes devices, vehicles, buildings which are embedded with sensor, micro-controller, and network associativity. It enables these items to get together and interchange data to the various environment.

The IoT journey has taken over a century to see light and it will undoubtedly not stop here. By 2020 it says that 50 billion `things' will be connected to the internet. In this guest, we tend to build a smart water quality checker.

1.2. SCOPE OF THE PROJECT

Aquaculture resources in India include 2.36 million of ponds and tanks, 0.798 million of flood plain lakes/derelict waters plus in addition 1,95,210 km of rivers and canals, 2.907 million of reservoirs and that could be utilized for aquaculture purposes. Inland fisheries contribute almost 65 percent of overall fish production of 10.1 million metric tonnes, and cultural fisheries contribute roughly the same. With 10.5 lakh tons in volume and 33,442 crores in value, fish and fish products have risen to become India's largest group of agricultural exports. In the present era of food insecurity, aquaculture shows enormous potential to feed not only the ever-increasing human population but also the aquaculture products can be utilized as a feed ingredient in the diets of different domesticated animals of high commercial value. The aquaculture sector has become a modern, dynamic industry that produces safe, high valuable and high-quality products, and has developed the means to be environmentally sustainable. Sustainable aquaculture is currently the need in India as elsewhere. Eco-friendly aquaculture in harmony with environmental and socio-economic needs of the society has to be evolved.

1.3. SOCIETAL / ENVIRONMENTAL IMPACT / NOVELTY OF IDEA

- A recent study from the UN shows that aquaculture can improve food security and nutrition by increasing the amount of seafood available for people to eat. If done correctly, aquaculture increases food production, boosts economic growth in coastal and rural areas, and can help keep waterways clean.
- Aquaculture could help decrease the effects of human consumption of fish on freshwater and marine water habitats by producing food without taking away from overfished environments.
- The significant of the study will help fish farmers to have a serene ecosystem for the fishes and create awareness to prevent further harm to the pond.
- There has been an increment in the world's demand for fishes. This occasion has required the need to take proper care of fish ponds. Due to change of water qualities brought about by high temperature, low water level, turbidity of the water among others. With more interest in fish farming there is a need to screen.
- We are applying Machine Learning algorithm on the data what we have collected and classifying the data as different classes based on the parameters of the water then try to enhance the accuracy level of prediction of the different classes of fish pond which helps immensely in cultivating the fish at every point of time.

CHAPTER 2

PROBLEM DEFINITION

CHAPTER 2 PROBLEM DEFINITION

From the past recent years, the consumption of fishes in World is on the rise. The government, in an effort to reduce fish imports and boost the country's production, has begun the development of a commercially viable aquaculture industry. As one of the fastest growing food-producing sectors in the world, aquaculture holds abundant job creation opportunities, while addressing the fish production deficit ("Development of aquaculture gains momentum", n.d). Imagine a device that screens the water and gives update of the chemical and physical properties. Water quality should be ensured so that no contaminants exceed levels that would affect the health of the fishes. A simplified technical procedure for monitoring and assessing water quality in the aquaculture is being developed. This system utilizes low cost, portable instrumentation that can largely be used by non-specialist fish farmers and reduces the need for costly analysis.

To apply the Machine Learning algorithm on the data what we have collected and classifying the data as different classes based on the parameters of the water then try to enhance the accuracy level of prediction of the different classes of fish pond which helps immensely in cultivating the fish at every point of time.

2.1. PURPOSE AND SIGNIFICANCE

The purpose of the study of this project is design and implement a water quality monitoring and notification system for fish farmers to determine the physio chemical parameters of aqua-cultured sites such as fish ponds.

The significant of the study will help fish farmers to have a serene ecosystem for the fishes and create awareness to prevent further harm to the pond.

CHAPTER 3

LITERATURE REVIEW

CHAPTER 3 LITERATURE REVIEW

1. Kun-Lin Tsai, Li-Woei Chen "IoT based Smart Aquaculture System with Automatic Aerating and Water Quality Monitoring".
    - ❖ In this research, an IoT-based smart aquaculture system (ISAS) is proposed for monitoring an aquafarm's water quality and automatically aerating it to improve aquatic life's survival rate.
    - ❖ Here the temperature, pH, dissolved oxygen, water hardness, an Arduino microcontroller, and a Raspberry Pi single-board computer have all been used.
    - ❖ Despite the ISAS's capability to monitor four major water quality indicators and instantly activate an aquafarm's actuator, water quality parameters including water hardness, nitrite, and nitrate must be identified to suit the requirements of different aquaculture systems.

2. Rosli Ismail "A Proposed Model of Fishpond Water Quality Measurement and Monitoring System based on Internet of Things (IoT)" 2020 IOP Conference Series: Earth and Environmental Science.
    - ❖ This paper proposes a concept for a real-time measuring and monitoring system based on IoT technology to test and monitor the water parameters in the fishpond.
    - ❖ They used a qualitative technique to investigate the beliefs, experiences, and theories of fishpond farmers in order to construct the model.
    - ❖ In this study, several sensors have been used, and the Raspberry Pi 3 microcontroller is in charge of managing them. It is also connected to a server, through which the parameters are saved and then shown on your devices.
    - ❖ The suggested methodology enables constant water quality testing and monitoring, ensuring the growth and survival of fish in ponds. Quick preventive action can therefore be taken to lessen losses and increase productivity.

3. Cesar Encinas , Erica Ruiz ,**“**Design and implementation of a distributed IoT system for the monitoring of water quality in aquaculture**”** 2018 IEEE **.**
    - ❖ In this paper, they have shown a distributed monitoring system prototype and proof of concept for the major factors influencing aquaculture water quality.
    - ❖ The approach proposed in this research uses the Internet of Things and wireless sensor networks to track the water quality (IoT).
    - ❖ Here, they've shown how to build a prototype and proof of concept for a remote monitoring system that checks the water quality in aquaculture using the Internet of Things and other technologies.

4. T. Abinaya, J. Ishwarya, M. Maheswari,**“**A Novel Methodology for Monitoring and Controlling of Water Quality in Aquaculture using Internet of Things (IoT)**”** 2019 International Conference on Computer Communication and Informatics (ICCCI).
    - ❖ In this study, a system based on the Internet of Things (IoT) was created for the goal of monitoring and managing the water parameters in aquaculture.
    - ❖ The system can monitor and modify a variety of parameters, including temperature, pH level, dissolved oxygen, water level, odour detection, and ammonia in the water.
    - ❖ The system can monitor and modify a variety of parameters, including temperature, pH level, dissolved oxygen, water level, odour detection, and ammonia in the water.

5. Yuda Irawan, Hendry Fonda ,**“**Intelligent Quality Control of Shrimp Aquaculture Based on Real-Time System and IoT Using Mobile Device.**”** 2021 International Journal of Engineering Trends and Technology.
    - ❖ IOT is being used in the study to monitor temperature, currents, and water. This monitoring is essential since it affects the development and success of shrimp farming.

- ❖ In this article, a scientific and sequential approach to software development is presented. Researchers used the Waterfall process for system design and development.
- ❖ The sensors receive data from the monitoring system ,comparing the results of the water Ph, temperature, and current meters' measurements to the information provided by the sensors' measurements.

6. Md. Mamunur RashidAl-Akhir Nayan,“IoT based Smart Water Quality Prediction for Biofloc Aquaculture” 2021 International Journal of Advanced Computer Science and Applications.
    - ❖ In this paper, they show how the manual aquaculture system may be transformed into a cutting-edge system by using Biofloc technology, which turns surplus feed into microbial protein and allows for its reuse.
    - ❖ The article describes a system that employs sensors to collect data, a machine learning model to analyse it, artificial intelligence (AI) to make decisions, and alerts to the user.
    - ❖ The suggested system's real-time water quality monitoring and prompt user alerting reduces the risk. Machine learning has been used to monitor the water quality.

7. Mengyuan Zhu, Jiawei Wang, Xiao Yang, Yu Zhang, Linyu Zhang, Hongqiang Ren, Bing Wu * , Lin Ye” A review of the application of machine learning in water quality evaluation” 2022 Eco-Environment & Health.
    - ❖ In the early days, many prototypes were built to monitor the quality of water because it is most important for human nutrition, but soon after, the population exploded, increasing the need for food, which led to the wilderness.
    - ❖ To fishing and depletion of fish. Prototypes of distributed monitoring systems and concept model prototypes were developed at that time to identify factors affecting aquaculture water quality.

8. Umar Farouk Mustapha, Abdul-Wadud Alhassan, Dong-Neng Jiang, Guang-Li Li., “Sustainable aquaculture development”2021 a review on the roles of cloud computing, internet of things and artificial intelligence (CIA). Whiley Online Library.
   - ❖ In the coming years, the intelligent aquaculture system based on IoT model was proposed to monitor the water quality of an aquaculture facility and automatically aerate it to improve the survival rate of aquatic organisms.
   - ❖ Temperature, pH, dissolved oxygen, water hardness, Arduino microcontroller and Raspberry Pi single board are used here.
   - ❖ Despite ISAS being able to monitor the four main water quality indicators and immediately activate an aquaculture plant actuary, water quality parameters namely as water hardness, nitrite and nitrate must be detected to meet the requirements of different aquaculture systems.
   - ❖ Many used to build a model to investigate the beliefs, experiences and theories of fishpond farmers using qualitative techniques.

9. K. Bala Ravi Teja; Mothika Monika; Chellu Chandravathi. “Smart Monitoring System for Pond Management and Automation in Aquaculture”.2020 IEEE Xplore.
   - ❖ Several sensors have been used and their management is controlled by a Raspberry Pi 3 microcontroller.
   - ❖ It is also connected to a server through which the parameters are stored and then displayed on your devices.
   - ❖ The proposed method enables continuous testing and monitoring of water quality, which ensures fish growth and survival in ponds.
   - ❖ Therefore, quick preventive measures can be taken to reduce losses and increase productivity.

10. Komal Desai; Harish Velingkar; Anushka Karambelkar; Mahima Rane. “Pisciculture Monitoring System”. 2020 IEEE Xplore.
    - ❖ A prototype and proof of concept of the distribution monitoring system of the most important factors affecting the quality of aquaculture water has been prepared.
    - ❖ This proposed approach uses Internet of Things and wireless sensor networks for water quality monitoring (IoT).
    - ❖ Here, it was shown how to create a prototype and proof of concept for a remote monitoring system that monitors aquaculture water quality using the Internet of Things and other technologies.
    - ❖ There are also studies that suggest creating an Internet of Things (IoT)-based system for monitoring and managing water characteristics in aquaculture.

11. Shehzad Ashraf Chaudhry; Khalid Yahya; Fadi Al-Turjman; Ming-Hour Yang. ”A Secure and Reliable Device Access Control Scheme for IoT Based Sensor Cloud Systems”.2022 IEEE Xplore.
    - ❖ There were also systems for monitoring and modifying several parameters namely temperature, Potential of Hydrogen (pH) level, dissolved O2 (oxygen), water level, odour detection and NH3 (ammonia) in the water.
    - ❖ IOT is used in scientific research to monitor temperature, currents, and water. This monitoring is necessary because it affects the development and success of fish farming.
    - ❖ A scientific and sequential approach to software development is presented here. The researchers used the Waterfall process to design and develop the system. The sensors receive data from the surveillance system via the Internet, which are then displayed in the smart application. comparing the results of water pH, temperature and flow measurements with the data provided by the sensors.

CHAPTER 4
PROJECT DESCRIPTION

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There has been an increase in the demand for dietary fish protein globally. This has resulted in overfishing in natural fisheries. To avoid complete depletion, fish farming / pisciculture is widely practiced across the world. Pisciculture involves breeding of fishes in artificial enclosures like ponds, tanks etc. It is a controlled cultivation where a pseudo natural environment has to be created to breed the fishes. Hence maintaining the water qualities like temperature, PH level, salinity, turbidity is of high importance.

In the course of recent years knowledge in electronics and computation has been utilized to solve present day problems. In the forefront of the electronics revolution has been internet of things. Sensors has been used to measure and control object. Maintaining water quality in fish pond can and has been automated. This solves the challenge brought about by the unreliability of climate changes thus need for water optimization. Fishes grown under controlled conditions tend to be healthier and thus give more yields.

This project is designed to accomplish the following objectives:

- To determine the water quality status/parameter in the fish ponds by developing a customized IOT board for the same.
- To develop a dash board with graphical visualization that will help the farmers to know about the water quality of the pond/lake/river
- To develop a website which will also display the real-time water quality data on a website and also send notifications to authorized Personnel/farmers.
- Send the Alert Notification to the authorized personnel.
- Then applying the Machine Learning algorithm on the data what we have collected and classifying the data as different classes based on the parameters of the water.
- And try to enhance the accuracy level of prediction of the different classes of fish pond which helps immensely in cultivating the fish at every point of time.

4.1. System Design:

This phase involves establishing the overall system. architecture by allocating requirements to hardware systems. Improved version of project is usually produced after each iteration. Suitable for a number of reasons, the iterative design model was chosen for the project. The implementation of this model was suitable due to challenges encountered and the model fairly improved the project as better working plans were produced.

The model enables the development of working functionality easily and quickly in the life cycle as it assumes subsequent release of the models adds function to the previous release. The iterative design model can be divided into four major phases.

- Requirement management: This phase involves capturing of requirements, putting them under specific categories and most importantly articulating the project needs in a formal and precise way.
- Design and development: This phase involves establishing the overall system architecture by allocating requirements to hardware systems. Improved version of project is usually produced after each iteration.
- Testing: In this phase, individual components are tested and again tested as an integrated system. Debugging processes are identified for further iteration of the improved version produced. Thus, enabling easier bug fixing in the next iteration.
- Implementation: From the information gathered during the requirement management and the design phases, the actual work is established and a final outcome is produced in this phase. Programming and debugging are considered as core activities or tasks.

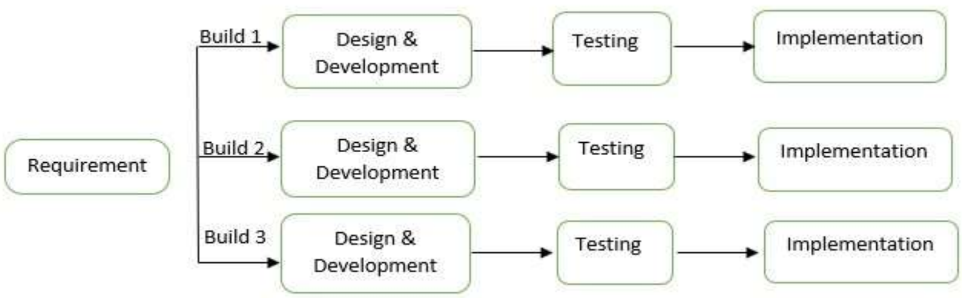

FIGURE 4.1: Iterative Model

This project makes use of the conceptual view of the system and real development system. Many programs or codes are gradually improved upon to ensure the proper functioning of hardware components. Versions of the web interface are developed, the easiest and most user friendly is selected as agreed by the team. Sequence diagram along with use case diagrams were considered for the sake of the project.

Sequence Diagram : The sequence diagram is used to define a sequence of events that are necessary to produce an outcome. The sequence diagram enables us to understand what happens when the user logs into the web interface. The diagram above represents the sequence diagram of the water quality monitoring system.

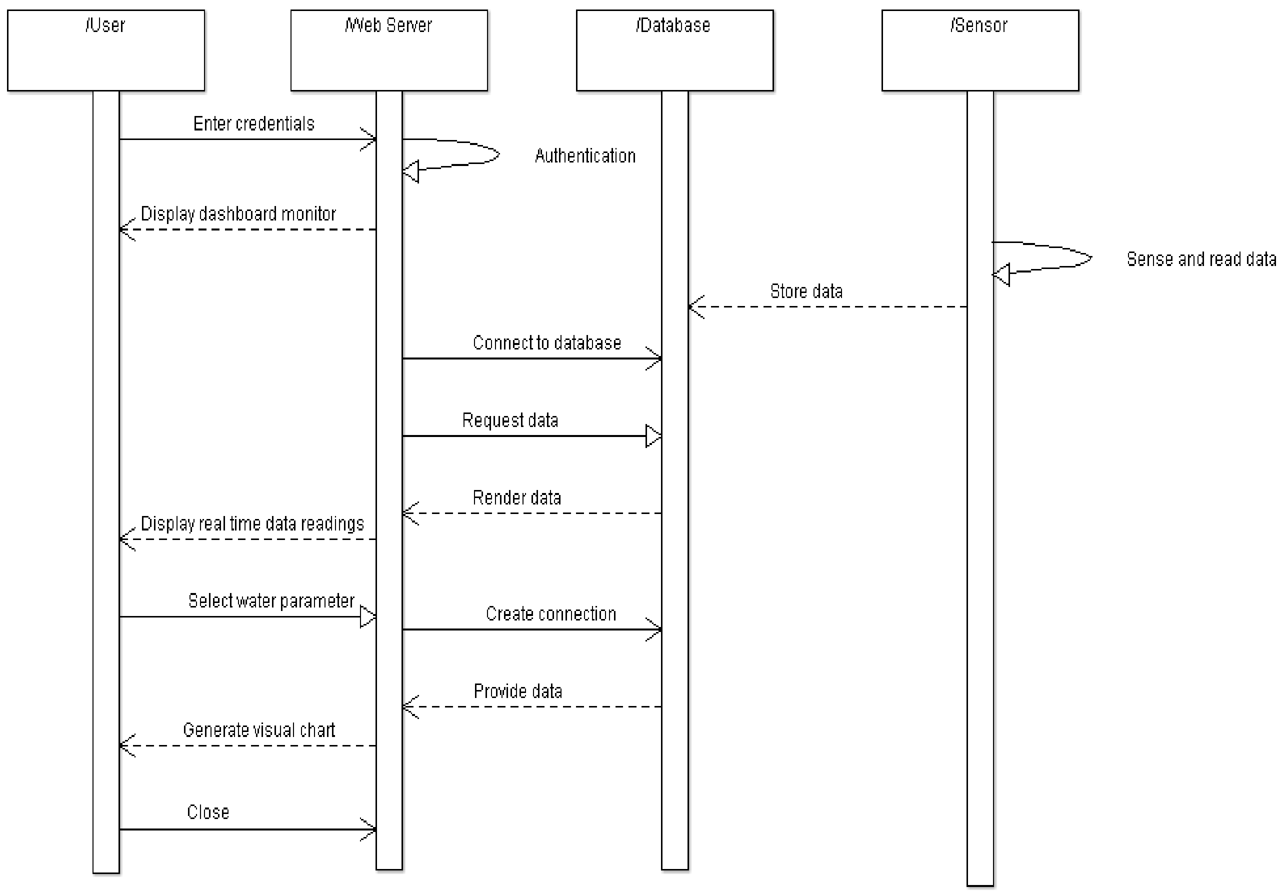

FIGURE 4.2 : Sequence Diagram

Use case Diagram : Use Case diagram is a graphical depiction of the interactions among the elements of a system. A use case is a methodology used in system analysis to clarify, identify and organize system requirements.

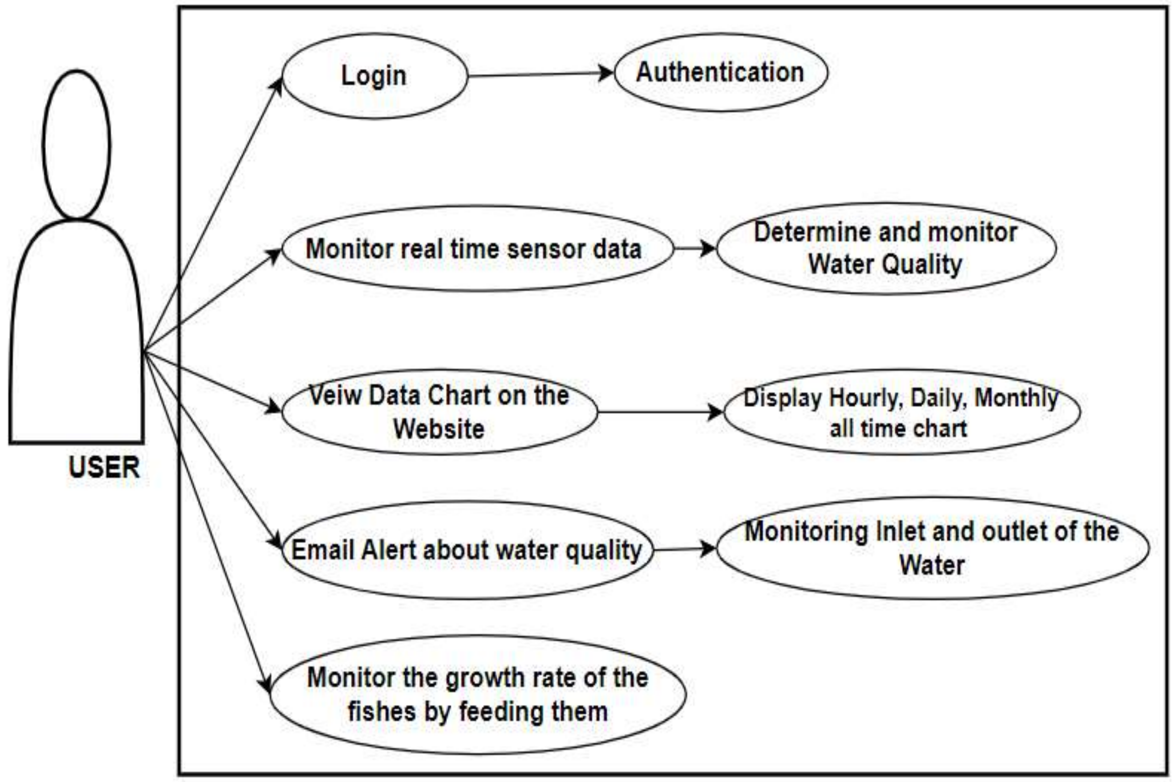

FIGURE 4.3: Use case Diagram

The above diagram represents the user case for the system. From the diagram, the system has the following functionalities:

- Read current water: the system checks the water level in the tank.
- Monitoring the system: Upload water level values, temperature, PH and turbidity onto the web interface.
- Storage: the system is able to store the values taken by recording them to a file and also uploading them to a database.
- Notification: The system includes an email alert interface that notifies the user for anomalies in readings.

4.2. ASSUMPTIONS AND DEPENDENCIES:

ASSUMPTIONS

- All sensors are calibrated as per standards.
- No glitches in internet connectivity.
- Proper working of the sensors and the Arduino.
- Proper connectivity between the local machine and Cloud server.
- Ideal growth rate of the fishes.
- Proper working of the laptop.

DEPENDENCIES

- Dependent on the Power Supply.
- Dependent on the proper working of the Sensors and Arduino.
- Depends on the life period of the fishes.
- Also depends on the Internet Connectivity.
- Dependent on the Machine Learning algorithm.

CHAPTER 5

REQUIREMENTS

CHAPTER 5 REQUIREMENTS

5.1. FUNCTIONAL REQUIREMENTS

❖ The project aims to develop a water monitoring system that measures some aspects of water quality.

The system should be able to do the following:

- Take correct reading of the set aspects of water quality.
- Upload data values unto our web interface.
- Allow users view the data.
- Notifying the users about the measured values via mails (short messages).
- Machine learning algorithm (Model) should predict the different classes of data approximately.

5.2. NON-FUNCTIONAL REQUIREMENTS

- User friendly web interface.
- Basic interpretation of data over a given period.
- Provide basic analysis of the values read.
- Web interface should work well on most devices.

5.3.HARDWARE AND SOFTWARE REQUIREMENTS

5.3.1. Hardware Requirements

- ESPDUINO -32
- Wi-Fi module
- Arduino uno
- Breadboard

- Temperature Sensor – DS18B20
- PH Sensor-E-201-C
- Turbidity Sensor- SKU: SEN0189
- Ultrasonic Sensor- HC-SR04
- Power Supply -9V battery
- Some Jumper Wires
- USB Cable Type B.

5.3.2. Software Requirements

- Arduino IDE
- Android App(Blynk APP)
- Blynk SMS Messaging API
- Operating system : WINDOWS/LINUX/MAC
- RAM: 4-8GB
- HTML
- CSS
- Python 3
- Google Colab / jupyter notebook.

CHAPTER 6
METHODOLOGY

CHAPTER 6 METHODOLOGY

This phase captures the detailed combination of the best practices, procedures, rules and guidelines observed to ensure completion and proper functioning of the project. The iterative design model was chosen for the project.

6.1. MODEL DESCRIPTION OF PROJECT KITS

We will first identify the required hardware(Arduino Family Series) and software components to achieve the mentioned objectives. All the hardware details are discussed in the section below and software details is discussed in the software requirement section above.

- Espduino32.
- Temperature Sensor and PH Sensor- DS18B20 and E-201-C.
- The Turbidity Sensor- SKU: SEN0189.
- An ultrasonic Sensor- HC-SR04.
- 9V battery.

6.1.1. Espduino32

ESPDUINO-32 development board base on ESP-32 Wi-Fi module, it can lead to all ESP32 module pins. With WIFI, Bluetooth 4.2, Ethernet, real-time map and other functions, ESPduino-32 is compatible with all version of Arduino expansion boards. The board features Control chip: Xtensa LX6 CPU, Figure 1: Iterative Model 18 UART/EN/SPI/ENTERNET /Bluetooth 4.2, DC 5V-12V, Average current: 80 mA.

FIGURE 6.1: Espduino-32

6.1.2. Temperature and PH sensor

The temperature sensor works great with any microcontroller using a single digital pin, can even connect multiple ones to the same pin. Usable with 3.0-5.0V systems. The analog pH meter, specially designed for Arduino controllers and has built-in simple, convenient and practical connection and features. It has an LED which works as the Power Indicator, a BNC connector and PH2.0 sensor interface. To use it, just connect the pH sensor with BNC connector, and plug the PH2.0 interface into the analog input port.

FIGURE 6.2: Temperature sensor

FIGURE 6.3: PH sensor

6.1.3. Turbidity Sensor

Turbidity sensor detects water quality by measuring level of turbidity. It is able to detect suspended particles in water by measuring the light transmittance and scattering rate which changes with the amount of total suspended solids (TSS) in water. As the TTS increases, the liquid turbidity level increases. The sensor has both analog and digital signal output modes. You can select the mode since threshold is adjustable in digital signal mode. Turbidity sensors can be used in measurement of water quality in rivers and streams, wastewater and effluent measurements, sediment transport research and laboratory measurements.

FIGURE 6.4: Turbidity Sensor

6.1.4. Ultrasonic sensor

The HC-SR04 Ultrasonic Module has 4 pins, Ground, VCC, Trig and Echo. The Ground and the VCC pins of the module needs to be connected to the Ground and the 5 volts pins on the Arduino Board respectively and the trig and echo pins to any Digital I/O pin on the Arduino Board. It emits an ultrasound at 40 000 Hz which travels through the air and if there is an object or obstacle on its path It will bounce back to the module. Considering the travel time and the speed of the sound, we can calculate the distance.

FIGURE 6.5: Ultrasonic Sensor

6.1.5. 9v Power Supply

This project uses a regulated 5V from battery that supplies 9V voltage. 5V power supply connected to main board, sensor board, LCD and relay board.

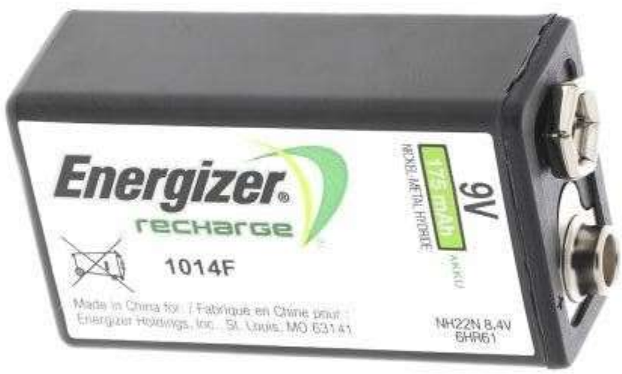

FIGURE 6.6: 9V Power Supply

6.2. METHODOLOGY OF THE PROJECT

1. After analyzing the requirements, Designing an IOT based hardware for measuring water quality. Here we are using four sensors named Ph Sensor, Turbidity Sensor, Ultrasonic Sensor, Temperature Sensor for measuring the values from the water.

2. Then Developing an algorithm to integrate the sensors to the Arduino board, which by the help of developed algorithm. Sensor will capture the live data of water quality and the same time the data will be transferred and stored in the cloud environment.

Block Diagram

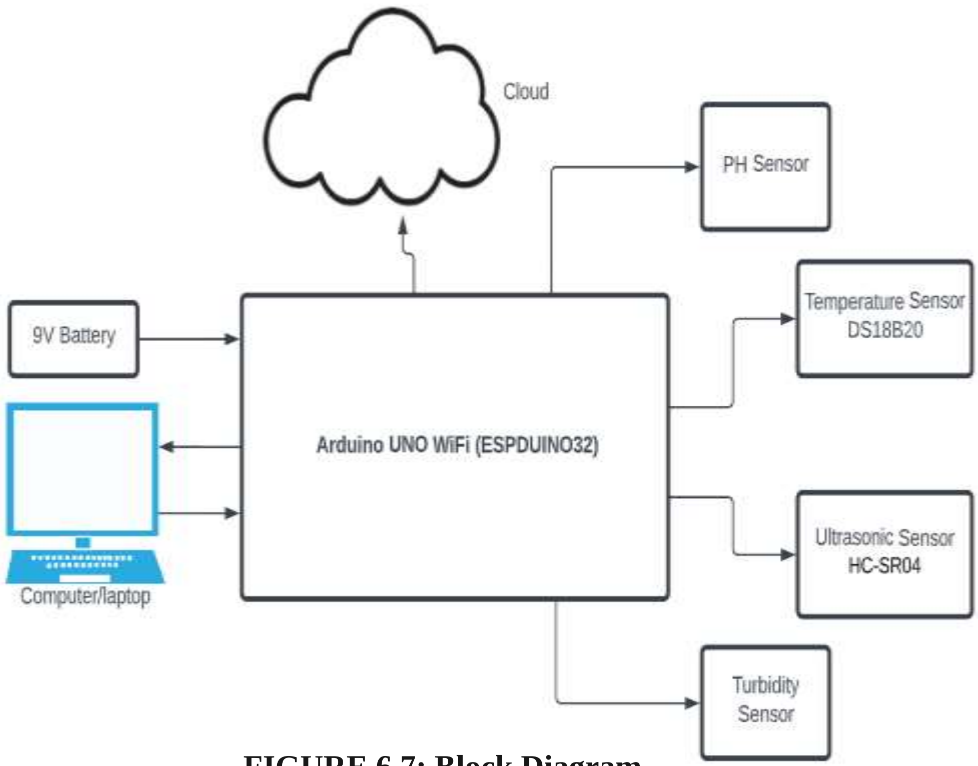

FIGURE 6.7: Block Diagram

- In this project we have four sensors namely Ph Sensor, Temperature Sensor, Turbidity Sensor, Ultrasonic Sensor.
- These Sensors are then integrated using wires with the Microcontroller in the Arduino.
- Then with the help of Arduino IDE we are able to compile the code in PC/Laptop , which then helps us to collect data from the sensors.

3. In addition to the previous methods there is a need to design and develop a multilingual APP/Website with dashboard which will help the farmer to get the precious insight information. The data collected in the System from which the collected data is graphically displayed in the user interface(Website).

Flow Chart is a type of diagram that represents an algorithm, work flow or process of the project.

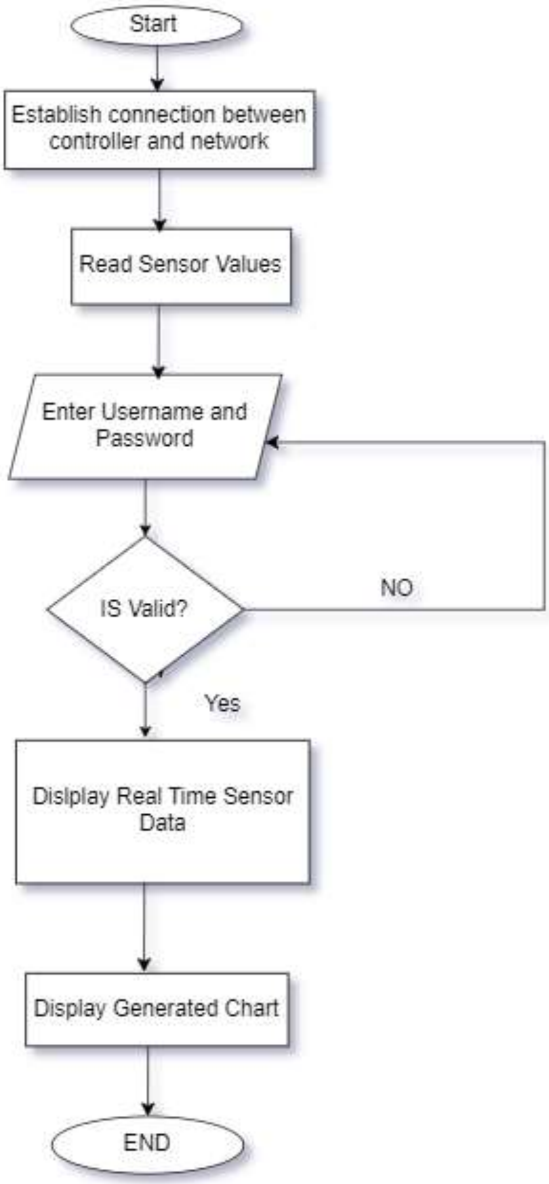

FIGURE 6.8:Flowchart of the proposed model

The flowchart below shows how we have used Machine learning for the future prediction. After collecting the data samples from various types of water , then applying machine learning for classifying the different classes of water. And analyse is it suitable for fish farming.

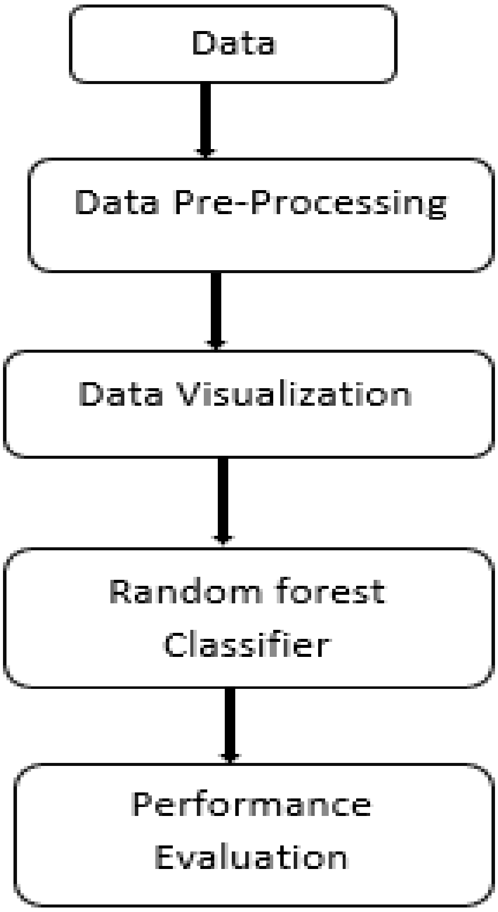

FIGURE 6.9:Flowchart of the Application of Machine Learning

CHAPTER 7

EXPERIMENTATION

CHAPTER 7 EXPERIMENTATION

In this project we have integrated three sensors namely pH, ultrasonic and temperature sensors which will help us to collect the values of physical and chemical properties of the water in which pisciculture is performed. These values will then be used to display graphically in the user interface which will be helpful for the breeders/farmers to have a knowledge of the water quality. The experimentation done with each sensor are shown below :

7.1. TEMPERATURE SENSOR WITH ARDUINO

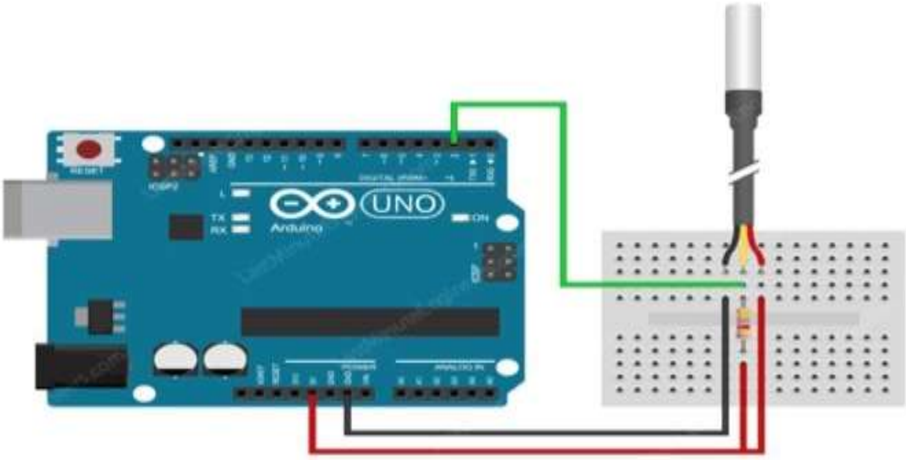

FIGURE 7.1:Temperature Sensor with Arduino

7.2.INTERFACING ULTRASONIC SENSOR WITH ARDUINO.

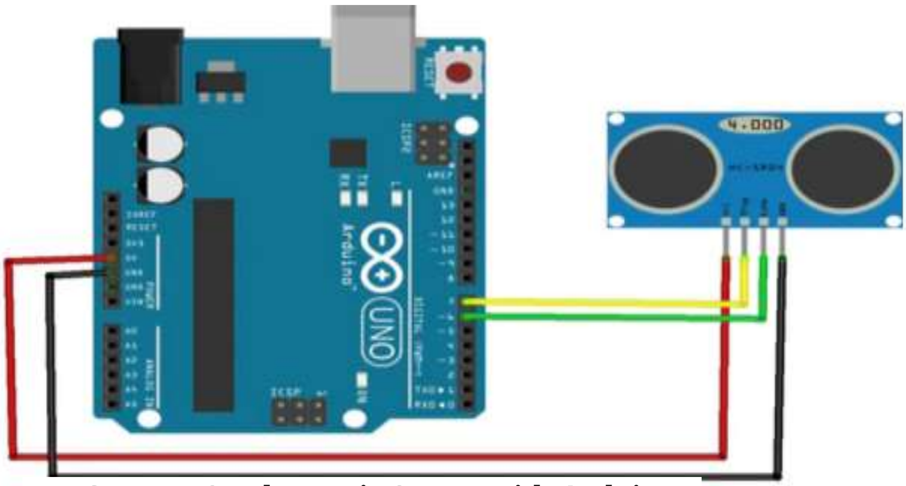

FIGURE 7.2: Ultrasonic Sensor with Arduino

7.3.INTERFACING PH SENSOR WITH ARDUINO.

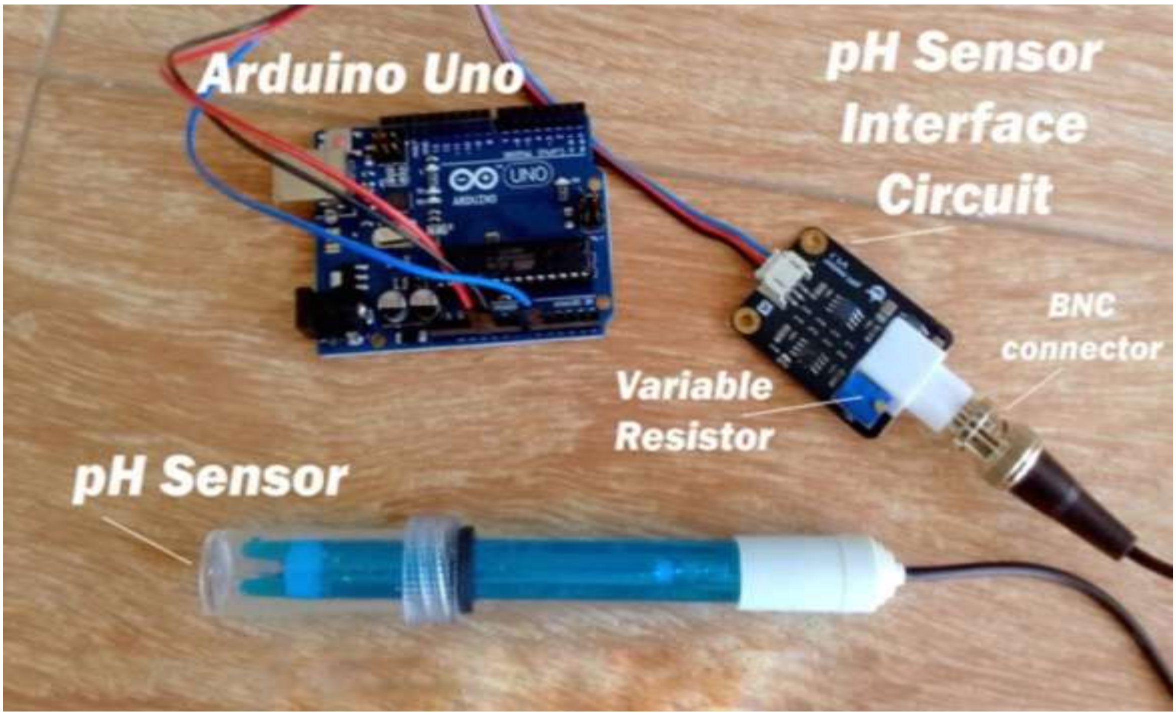

FIGURE 7.3: PH Sensor with Arduino

7.4.INTERFACING TURBIDITY SENSOR WITH ARDUINO.

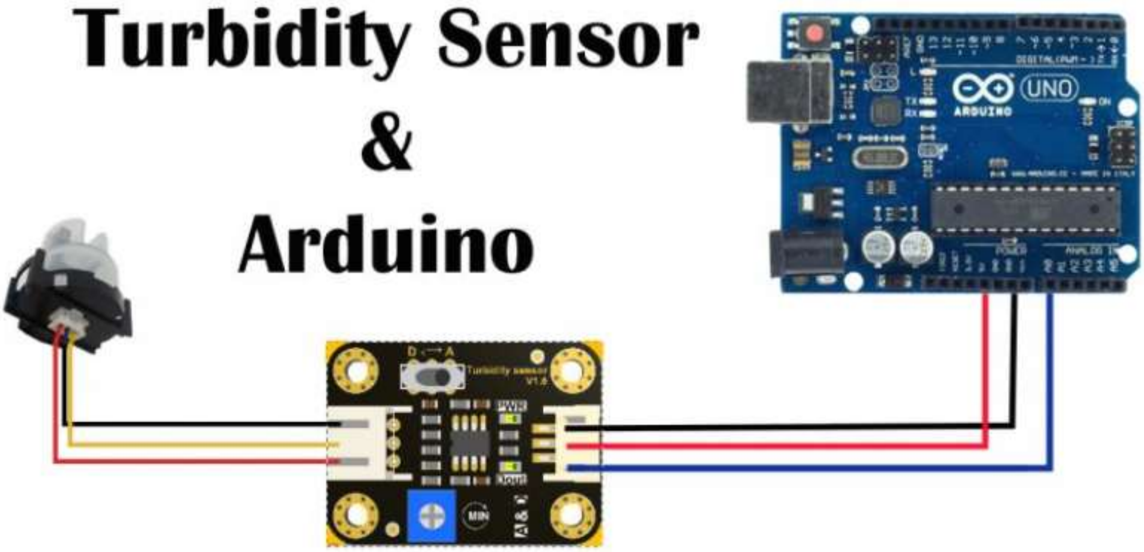

FIGURE 7.3: Turbidity Sensor with Arduino

7.5. IMPLEMENTATION OF THE CODE

7.5.1.Temperature sensor:

The sketch begins by including the `OneWire.h` and `DallasTemperature.h` libraries and declaring the Arduino pin to which the sensor's signal pin is connected.

```
#include <OneWire.h>
#include <DallasTemperature.h>
```

FIGURE 7.4: Turbidity Sensor with Arduino

To communicate with the DS18B20 sensor, we do two things. First, we create a one-wire object and pass the sensor's signal pin as a parameter. Second, we create a DallasTemperature library object and pass the reference of the one-wire object (that we just created) as a parameter.

```
OneWire oneWire(ONE_WIRE_BUS);
DallasTemperature sensors(&oneWire);
```

we call the `requestTemperatures()` function, which instructs all sensors on the bus to perform a temperature conversion.

Then we call the `getTempCByIndex(deviceIndex)` function, where `deviceIndex` is the location of the sensor on the bus. This function reads the temperature reading from the corresponding sensor and returns it.

```
void loop(void) {

  // Send the command to get temperatures

  sensors.requestTemperatures();

  //print the temperature in Celsius
```

```
  Serial.print("Temperature: ");

  Serial.print(sensors.getTempCByIndex(0));

  Serial.print((char)176);//shows degrees character

  Serial.print("C  |  ");

  //print the temperature in Fahrenheit

  Serial.print((sensors.getTempCByIndex(0) * 9.0) / 5.0 + 32.0);

  Serial.print((char)176);//shows degrees character

  Serial.println("F");

 delay(500);

}
```

7.5.2. Ultrasonic Sensor:

```
defining the pins

const int trigPin = 9;
const int echoPin = 10;

defining variables
long duration;
int distance;

Sets the trigPin as an Output
pinMode(trigPin, OUTPUT);
```

Sets the echoPin as an Input
pinMode(echoPin, INPUT);

Reads the echoPin, returns the sound wave travel time in microseconds
duration = pulseIn(echoPin, HIGH);

Calculating the distance
distance= duration*0.034/2;

7.5.3. PH Sensor:

Defining the libraries

```
#define ph_sensor A0

float ph_value,sensor_value=0;

void setup() {

  // put your setup code here, to run once:

  Serial.begin(9600);

}

void loop() {

  // put your main code here, to run repeatedly:

  ph_value = analogRead(ph_sensor);

  sensor_value=(ph_value-200)/35;

  Serial.print("ph_value = ");

  Serial.println(sensor_value);

  delay(1000);

}
```

7.5.4. Turbidity Sensor:

```
//Defining the pins
#define analogpin 2
void myturb(){
  int sensorValue = analogRead(analogpin);
  float voltage = sensorValue * (5.0 / 1024.0);


  Serial.print ("TURBIDITY VALUE OUTPUT (V):");
  Serial.print (sensorValue);
   if (voltage>3.2 ){
     Serial.print("\t Water is clear \n");
    }
  else if (voltage<3.2 && voltage>2.9 ){
     Serial.print("\t Water is a little cloudy \n");
    }
  else if(voltage<2.9){
    Serial.print("\t Warning!!. Water is muddy/very cloudy!!! \n");
  }
  Blynk.virtualWrite(V3,sensorValue);
    delay(1000);
}
```

7.5.5. Send Data from Hardware to Blynk:

Blynk can work with any sensor. With Blynk you can send any raw or processed data from any sensor or actuator. When you send data to Blynk it flows through a Datastream using Blynk protocol. Then every value is automatically timestamped and stored in the Blynk.Cloud database (you can also send batches of timestamped data if needed).Datastream is a channel that tells Blynk what type of data is flowing through it.

Virtual Pins Datastream ,We are already familiar with Digital and Analog pins which are used on your hardware to transfer data from connected sensors. Virtual Pins are a Blynk abstraction designed to exchange any data between your hardware and Blynk. Anything you connect to your hardware will be able to talk to Blynk.

```
// Declaring a global variable for sensor data
int sensorVal;


// This function creates the timer object. It's part of Blynk library
BlynkTimer timer;


void myTimer()
{
  // This function describes what will happen with each timer tick
  // e.g. writing sensor value to datastream V5
  Blynk.virtualWrite(V5, sensorVal);
}
void setup()
{
  //Connecting to Blynk Cloud
```

```
  Blynk.begin(auth, ssid, pass);


  // Setting interval to send data to Blynk Cloud to 1000ms.
  // It means that data will be sent every second
  timer.setInterval(1000L, myTimer);
}
void loop()
{
  // Reading sensor from hardware analog pin A0
  sensorVal = analogRead(A0);

  // Runs all Blynk stuff
  Blynk.run();

  // runs BlynkTimer
  timer.run();
}
```

7.5.6. Code Implementation Of Machine Learning:

```
# import necessary libraries
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import accuracy_score
```

```
# load data
data = pd.read_csv('hem.csv')

# Data Visualization
import seaborn as sns
import matplotlib.pyplot as plt
sns.pairplot(data)
plt.show()
plt.hist(data['Temp(°C)'], bins=20)
plt.xlabel('Temperature (°C)')
plt.ylabel('Frequency')
plt.show()

# Box Plot
plt.boxplot(data['Water Purity'])
plt.xlabel('Water Purity')
plt.show()

# Co-relation Matrix
corr_matrix = data.corr()
sns.heatmap(corr_matrix, annot=True, cmap='Blues')
plt.show()
```

```
# Label Encoding

from sklearn.preprocessing import LabelEncoder

import pandas as pd

encoder = LabelEncoder()


# Encode each object column with the LabelEncoder

for col in data.columns:

    if data[col].dtype == 'object':

        data[col] = encoder.fit_transform(data[col])


# Save the encoded data to a new CSV file

data.to_csv('encoded_waterdata.csv', index=False)

# separate target variable

target = data['target column']

features = data.drop('target column', axis=1)


# split data into training and testing sets

X_train, X_test, y_train, y_test = train_test_split(features, target, test_size=0.2, random_state=42)

# build random forest classifier

rfc = RandomForestClassifier(n_estimators=100, max_depth=5, random_state=42)

rfc.fit(X_train, y_train)


# make predictions on test data

y_pred = rfc.predict(X_test)
```

```
# evaluate model performance
accuracy = accuracy_score(y_test, y_pred)
print('Accuracy:', accuracy)

# Load the trained model
import numpy as np
rfc = RandomForestClassifier(n_estimators=100, max_depth=5, random_state=42)
rfc.fit(X_train, y_train)

# Create a dictionary to store the feature values entered by the user
user_input = {}
# Ask the user to enter the feature values
user_input['Temp(°C)'] = float(input('Enter the temperature in degrees Celsius: '))
user_input['Temp(°F)'] = float(input('Enter the temperature in degrees Fahrenheit: '))
user_input['Water Range(cm)'] = float(input('Enter the water range in cm: '))
user_input['Water Level'] = int(input('Enter the water level: '))
user_input['Turbidity(Voltage)'] = float(input('Enter the turbidity voltage: '))
user_input['Water Purity'] = float(input('Enter the water purity value: '))
user_input['pH level'] = float(input('Enter the pH level: '))

# Convert the user input dictionary into a numpy array
user_input_array = np.array([list(user_input.values())])
# Make predictions using the random forest classifier
output = rfc.predict(user_input_array)[0]
```

```
# Define a dictionary to map the labels to the corresponding values
label_map = {0: 'Impure', 1: 'Medium', 2: 'Normal'}
# Use np.where() to replace the predicted value with the corresponding label
output = np.where(output == 0, 'Impure', np.where(output == 1, 'Medium', 'Normal'))
# Print the predicted output
print('The water is classified as:', output)
```

7.5.7.Algorithm

Random Forest is a classifier algorithm that contains a number of decision trees on various subsets of the given dataset and takes the average to improve the predictive accuracy of that dataset. Instead of relying on one decision tree, the random forest takes the prediction from each tree and based on the majority votes of predictions, and it predicts the final output.

The greater number of trees in the forest leads to higher accuracy and prevents the problem of overfitting.

Random Forest works in two-phase first is to create the random forest by combining N decision tree, and second is to make predictions for each tree created in the first phase.

The Working process can be explained in the below steps and diagram:

Step-1**:** Select random K data points from the training set.

Step-2**:** Build the decision trees associated with the selected data points (Subsets).

Step-3**:** Choose the number N for decision trees that you want to build.

Step-4**:** Repeat Step 1 & 2.

Step-5: For new data points, find the predictions of each decision tree, and assign the new data points to the category that wins the majority votes

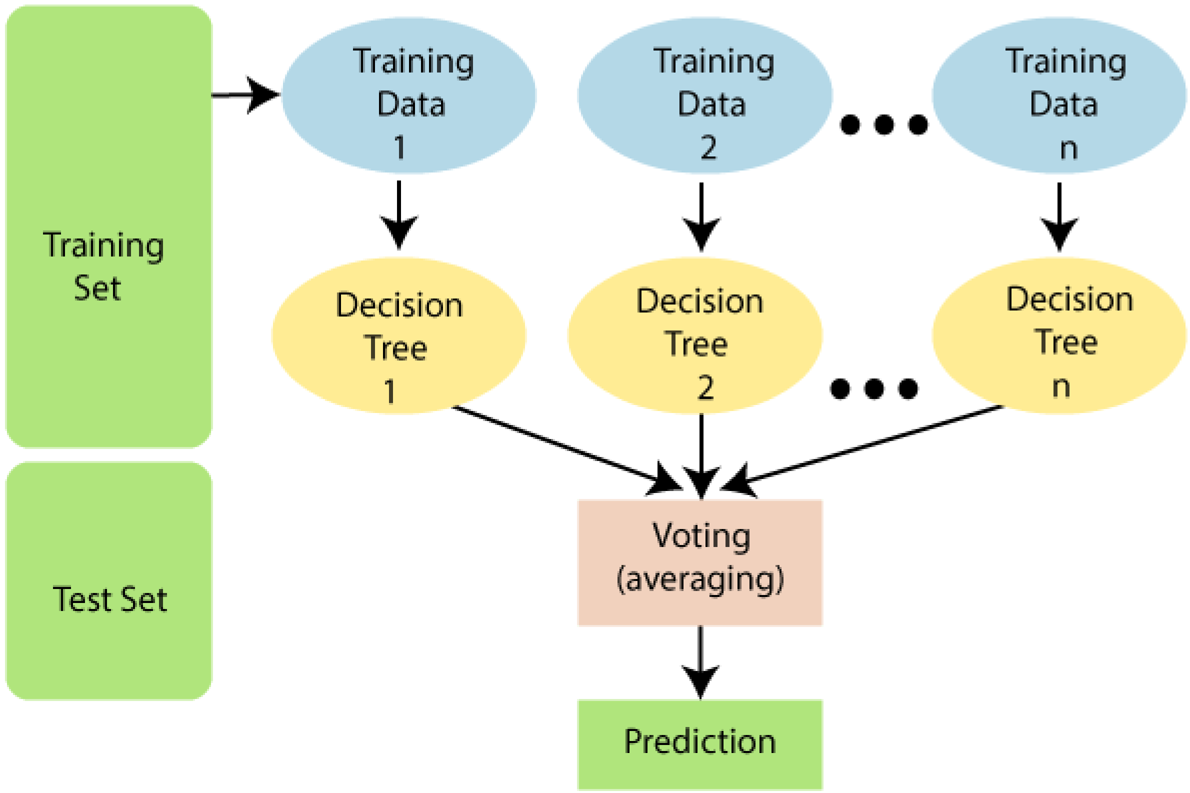

FIGURE 7.4: Random Forest Classifier Algorithm

7.6.PROBLEMS FACED DURING EXPERIMENTATION:-

- Building the circuits, integrating each sensor with Arduino.
- Analyzing the code for moving the data to the cloud.
- Figuring out the code in the Arduino to configure the sensors.
- Ideal place to test the prototype which is developed.

CHAPTER 8
TESTING AND RESULTS

CHAPTER 8 TESTING AND RESULTS

8.1.TESTING OF SENSORS

Testing the water proof temperature sensor DS18B20 connect the red wire to 5V, the black wire to ground, and the yellow wire to digital pin 2 on the Arduino. You still have to connect a 4.7K pullup resistor between the data and the 5V.

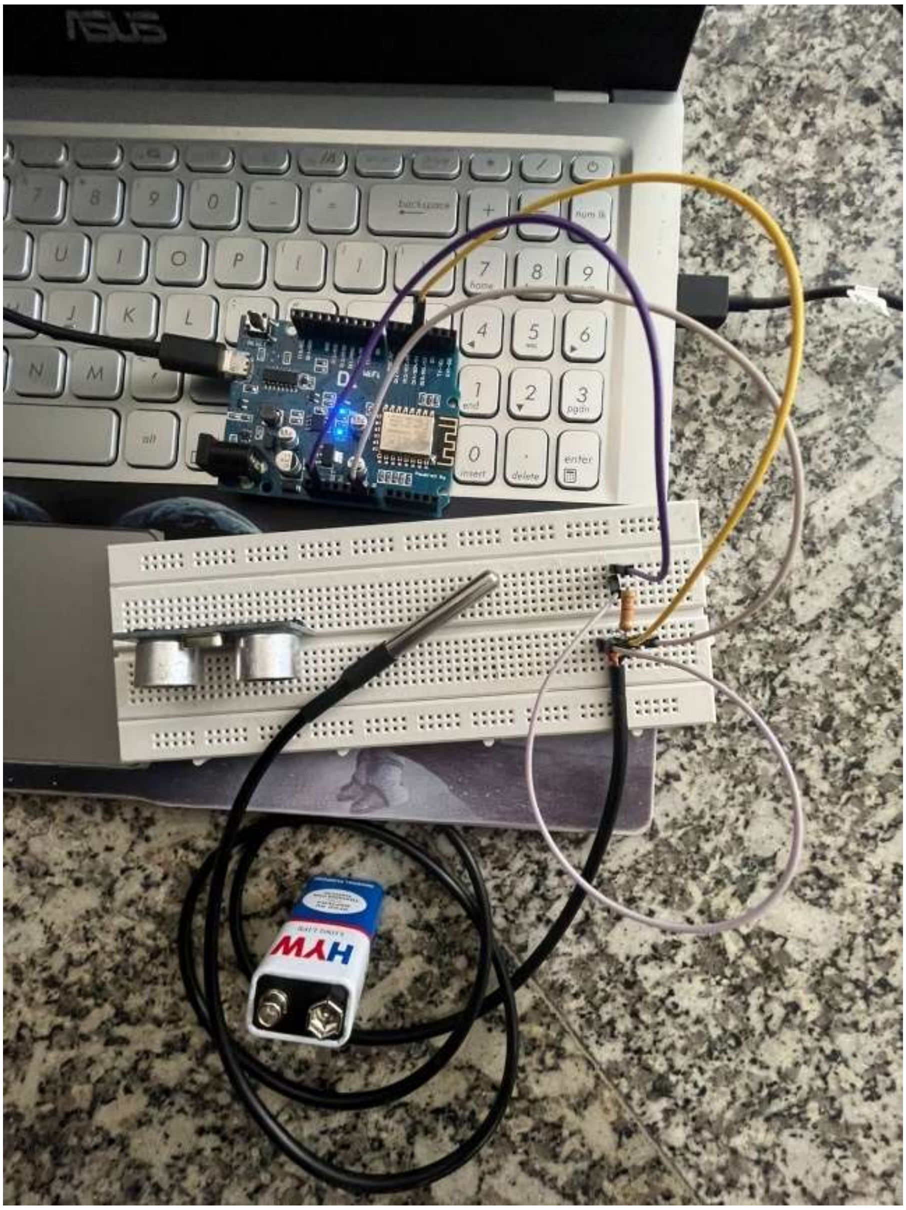

FIGURE 8.1.: Temperature Sensor Testing

The HC-SR04 is an ultrasonic ranging module. This economical sensor provides 2cm to 400cm of non-contact measurement functionality with a ranging accuracy that can reach up to 3mm. Each HC-SR04 module includes an ultrasonic transmitter, a receiver and a control circuit.

There are **Four Pins** on the HC-SR04. They are :

- Vcc (5V supply)
- Gnd (Ground)
- Trig (Trigger)
- Echo (Receive)

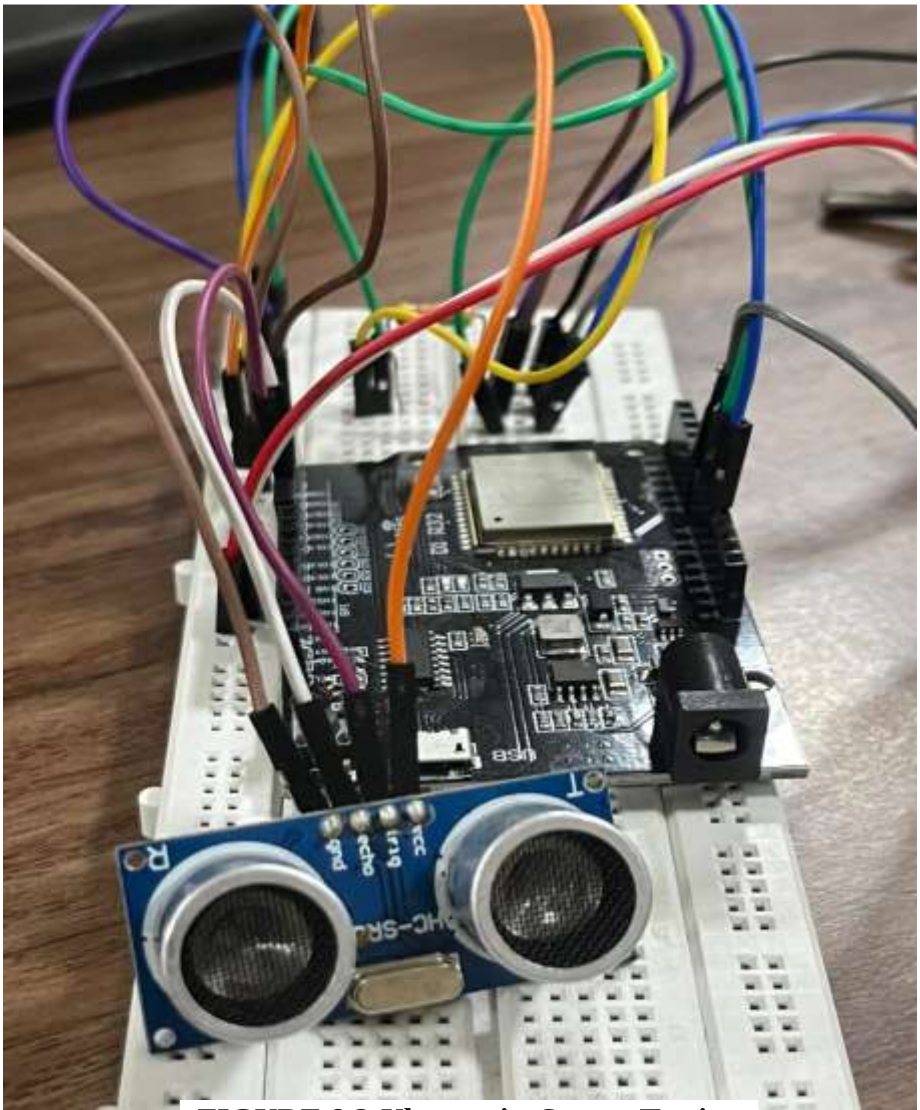

FIGURE 8.2:Ultrasonic Sensor Testing

pH Sensor Kit can measure pH values of different liquids with a good precision. To calibrate this sensor you will need a wire to short the external part and the center of the probe connector. This causes a 2.5 volts tension on the Po analog output pin. I started off by connecting the external part of the BNC connector with the center of the BNC probe connector.

Now connect the V+ pin with the Arduino's 5v. Connect the ground pin of the interface circuit with the ground pin of the Arduino, and finally connect the analog output pin Po with the A0 pin of the Arduino.

Connect Arduino with the laptop to calibrate the pH sensor using the following Arduino code.

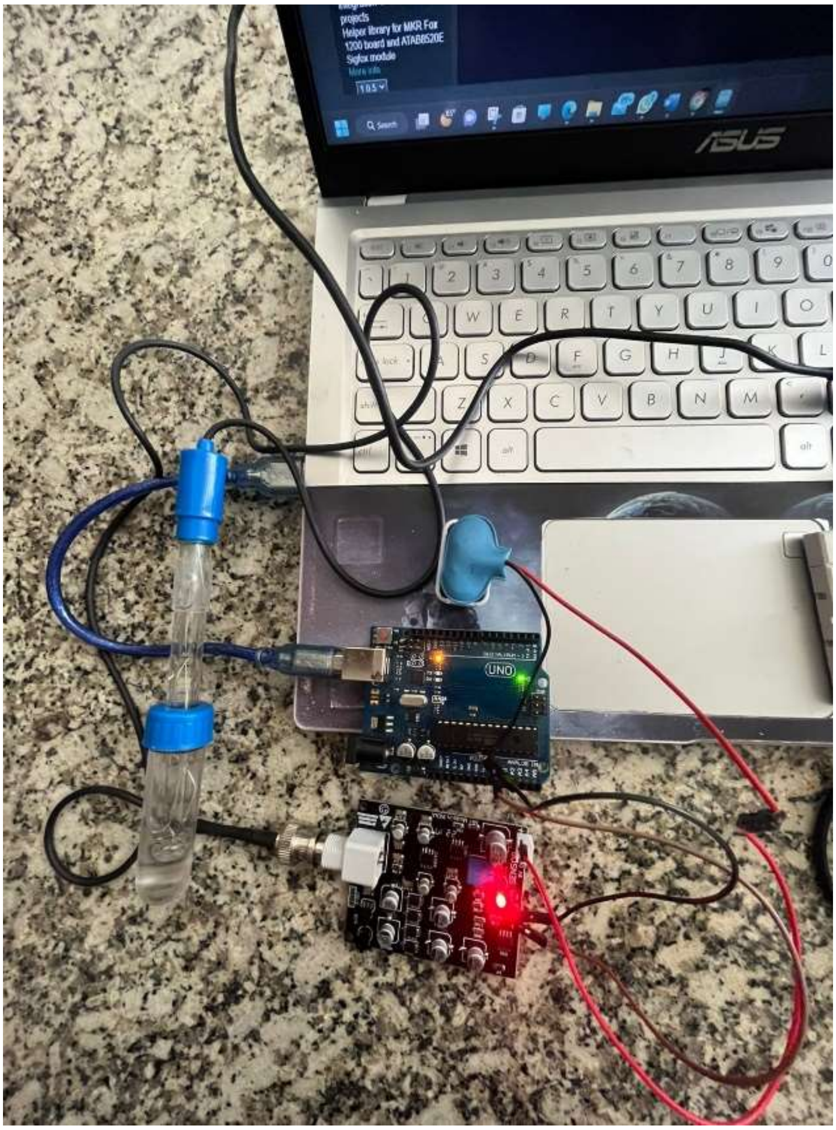

FIGURE 8.3:PH Sensor Testing

Turbidity is the cloudiness or haziness of a fluid caused by large numbers of individual particles that are generally invisible to the naked eye, similar to smoke in the air. Turbidity is caused by particles suspended or dissolved in water that scatter light making the water appear cloudy or murky. The measurement of turbidity is a key test of water quality.

Connect the VCC of the Turbidity Sensor with Arduino 5V, GND to GND & Analog Output to Arduino A0 pin as shown in the image above.

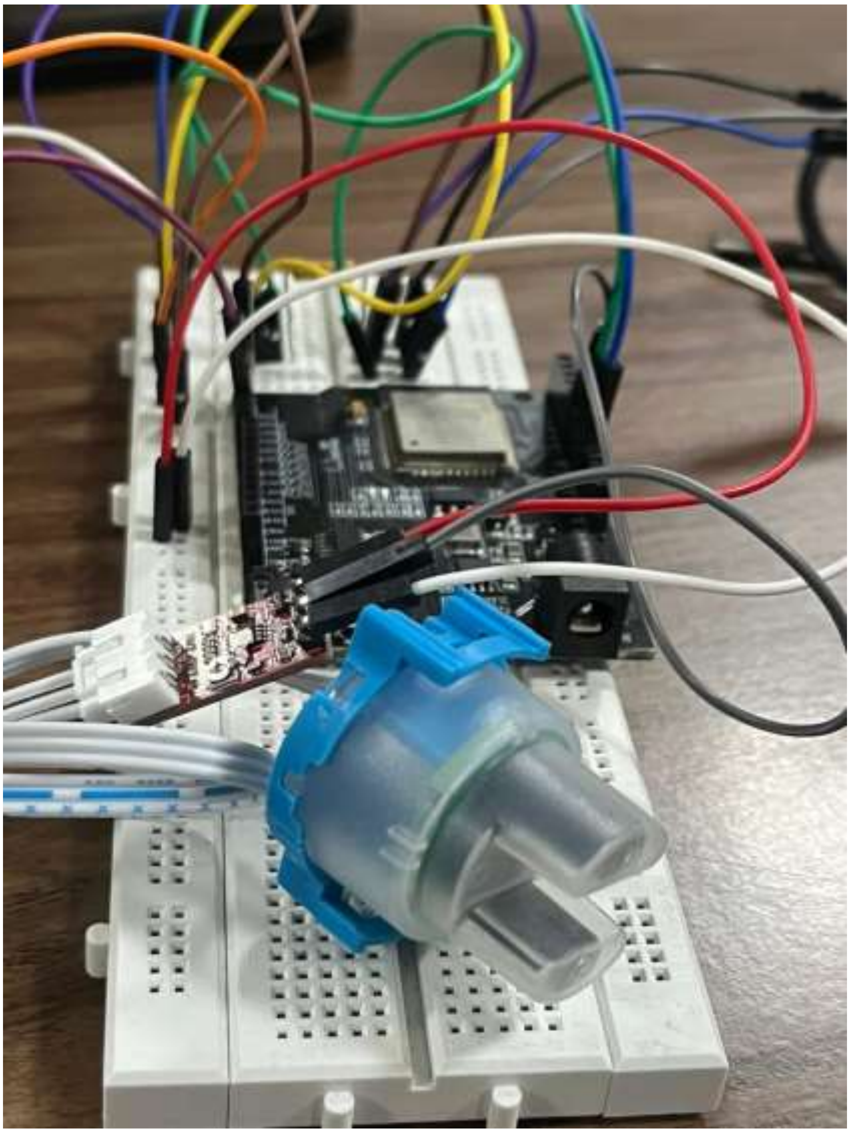

FIGURE 8.4:Turbidity Sensor Testing

8.2. TEST CASES AND RESULTS

The test case analysis refers to the actions required to verify a specific feature or functionality in the sensors and the applications.

Table 8.1. Test cases of the sensors

Sl. NO	pH Sensor			Temperature Sensor (Degree Celsius)			Turbidity Sensor (Voltage)			Ultrasonic Sensor (Centi-meters) Tank Height:- 100cm		
	EV	VA	PASS/ FAIL	EV	VA	PASS/ FAIL	EV	VA	PASS/ FAIL	EV	VA	PASS/ FAIL
1.	7.1 -9.2	7.3	PASS	27-33	27.5	PASS	< 3.5	2.6	FAIL	75-100	78	PASS
2.	7.1 -9.2	7.8	PASS	27-33	28.2	PASS	< 3.5	4.6	PASS	75-100	82	PASS
3.	7.1 -9.2	6.3	FAIL	27-33	58.6	FAIL	< 3.5	4.2	PASS	75-100	81	PASS
4.	7.1 -9.2	8.3	PASS	27-33	32.1	PASS	< 3.5	3.1	FAIL	75-100	73	FAIL
5.	7.1 -9.2	9.3	FAIL	27-33	24.3	FAIL	< 3.5	3.8	PASS	75-100	69	FAIL

EV- Expected Values
VA – Values Achieved

Table 8.2. Test cases of applications

SL. NO	WORKING OF BLYNK APPLICATION				WORKING OF MACHINE LEARNING APPLICATION	
	SIGN UP & LOGIN TO THE APPLICATION	DATA SENT TO BLYNK	DATA VISUALISED ON BLYNK	PASS/FAIL	PREDICTION OF CLASSES OF DATA	PASS/FAIL
1.	YES	YES	YES	PASS	YES	PASS
2.	NO	YES	NO	FAIL	YES	PASS
3.	YES	YES	YES	PASS	NO	FAIL

All the sensors i.e., temperature sensor , ultrasonic sensor, pH sensor, turbidity sensors are integrated to the Espduino-32. Then measured the all the values of the sensors by integrating all the codes of the appropriate sensors in Arduino IDE.

The data collected from all the sensors then sent to the cloud that is blynk cloud and displaying all the values collected in the form data visualization in graphical user interface.

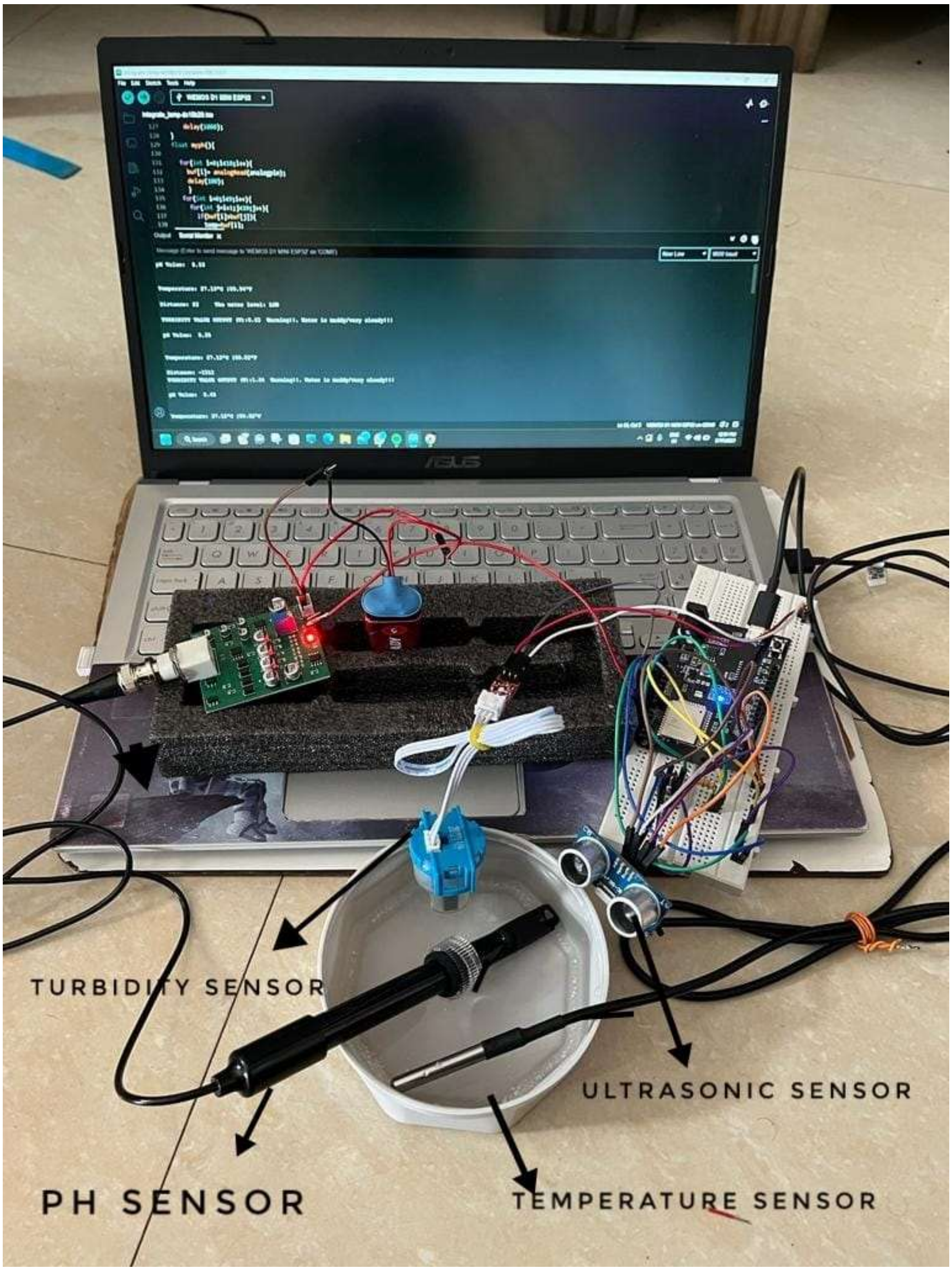

FIGURE 8.5:Prototype of All Working Sensors

8.3.OUTPUT SCREENSHOTS:

Measures water temperature, depth, turbidity and pH of water with optimum ranges Turbidity (Nephelometric Turbidity Units or Jackson Turbidity Unit) 0-5 pH 4-10 Water level 5-27 (based on site).27 degree Celsius -100 degree Celsius .The sensors allowed us to determine the water's properties, which, if maintained properly, will result in effective fish breeding. This is significant because of the growing population, the abrupt rise in demand for food goods, and the exponential rise in demand for seafood products, which causes overfishing and fish depletion. Aquaculture or pisciculture is thus practiced. The parameters must therefore be maintained during this operation to help cultivating the fishes.

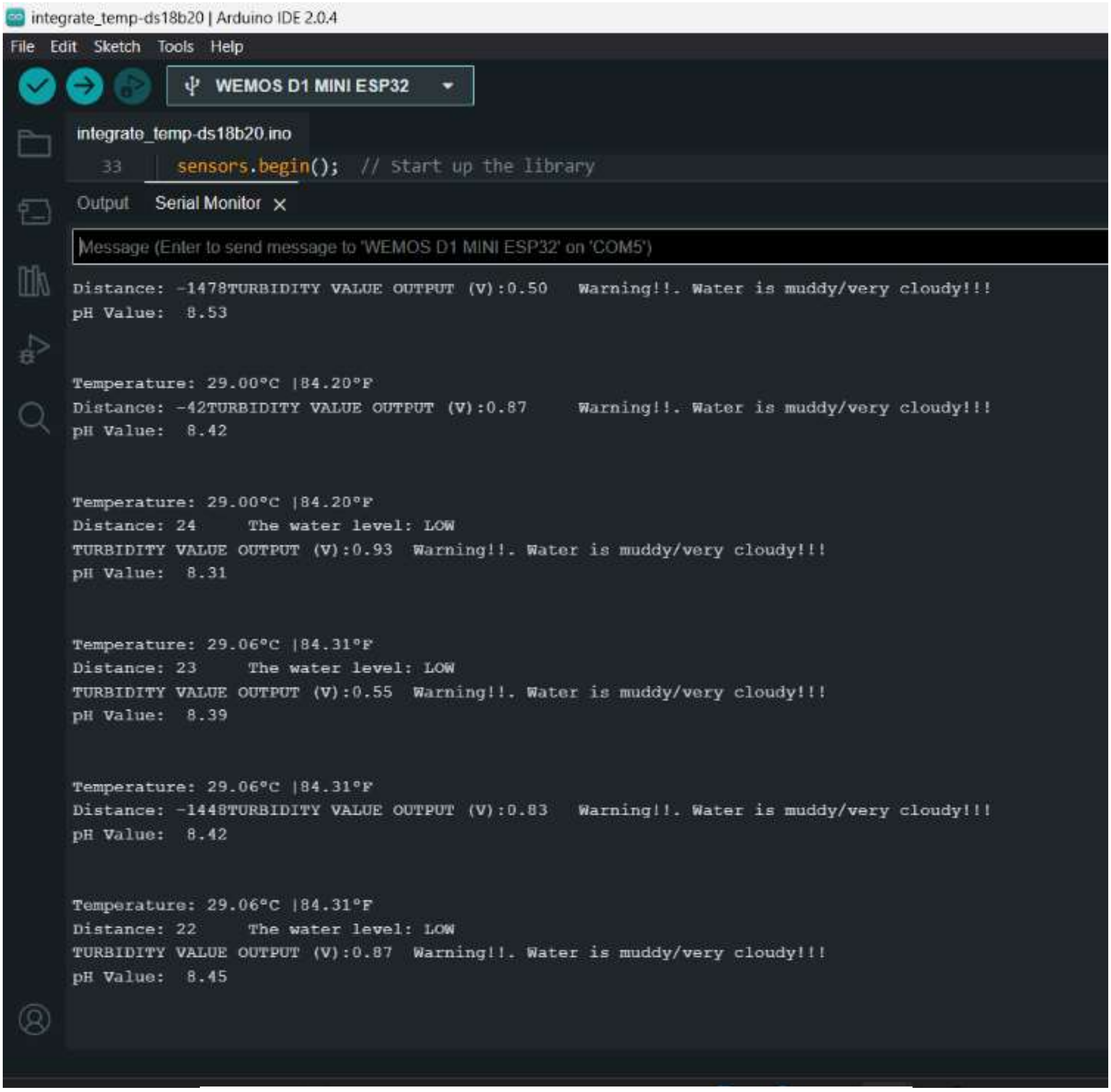

FIGURE 8.6: Output of All Sensors

All the sensors data will then be sent to the cloud web server, and publishes the data on webpage. Due to the graphical representation, it helps the fish farmers to analyse and take actions when the parameters vary, in this presentation the colour changes when it exceeds the given ideal parameters. During the experimentation phase of this project, we have shown multiple graphical representation of each sensor with varied values.

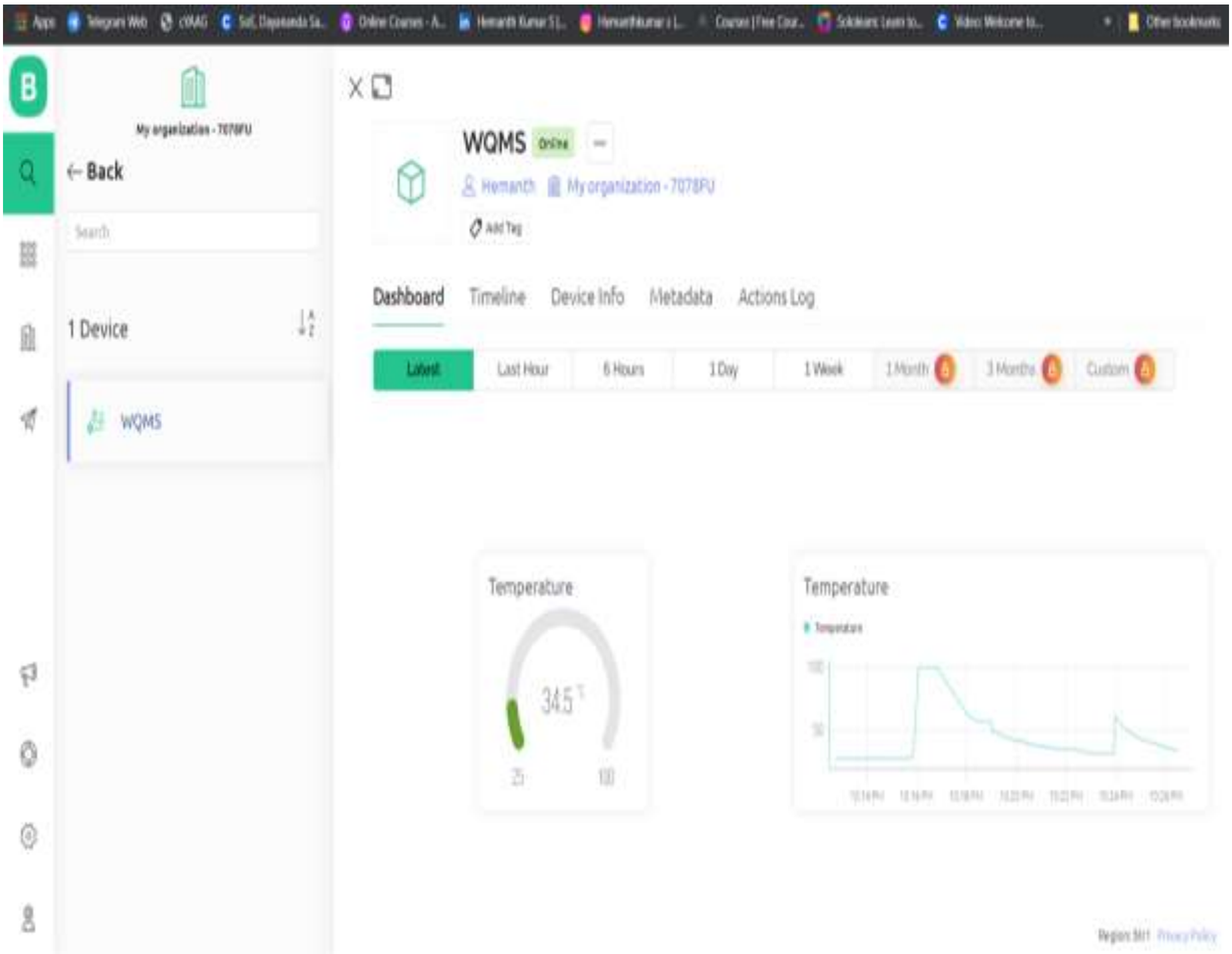

FIGURE 8.7: Web Interface Output of Temperature

This monitoring is necessary because it affects the development and success of fish farming. m. The sensors receive data from the surveillance system via the Internet, which are then displayed in the smart application. comparing the results of water pH, temperature and flow measurements with the data provided by the sensors.

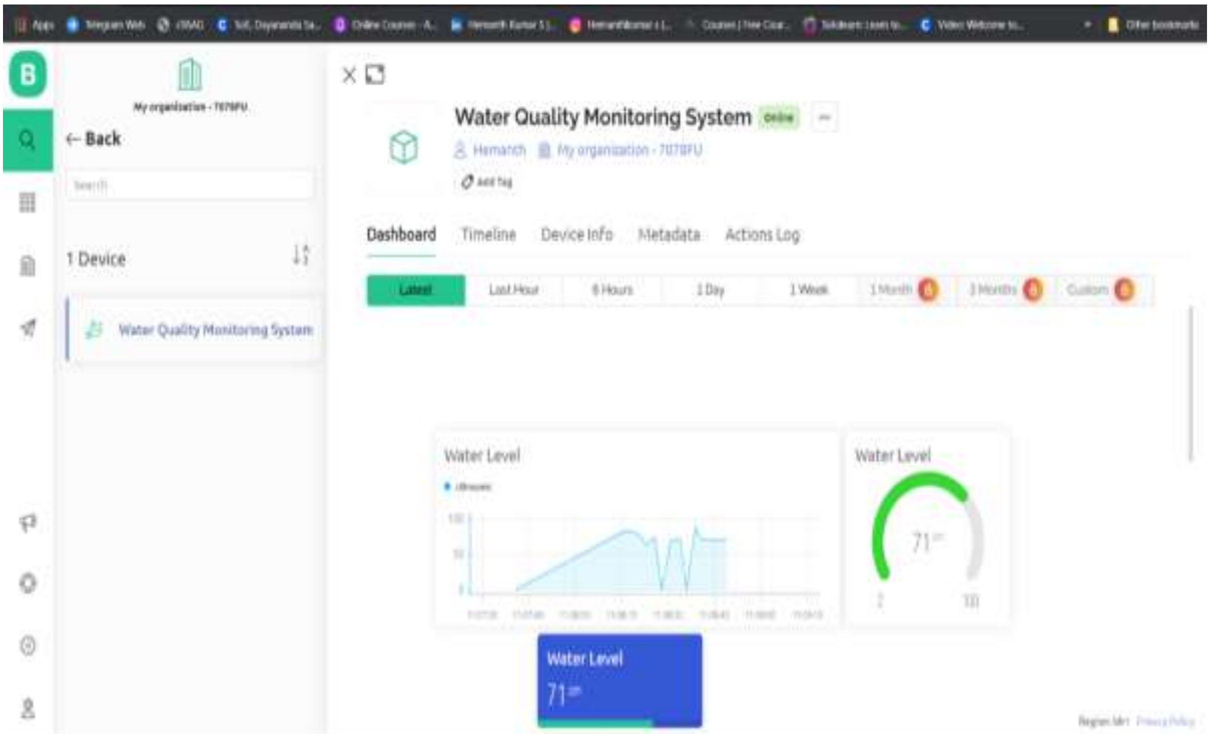

FIGURE 8.8: Web Interface Output of Ultrasonic Sensor

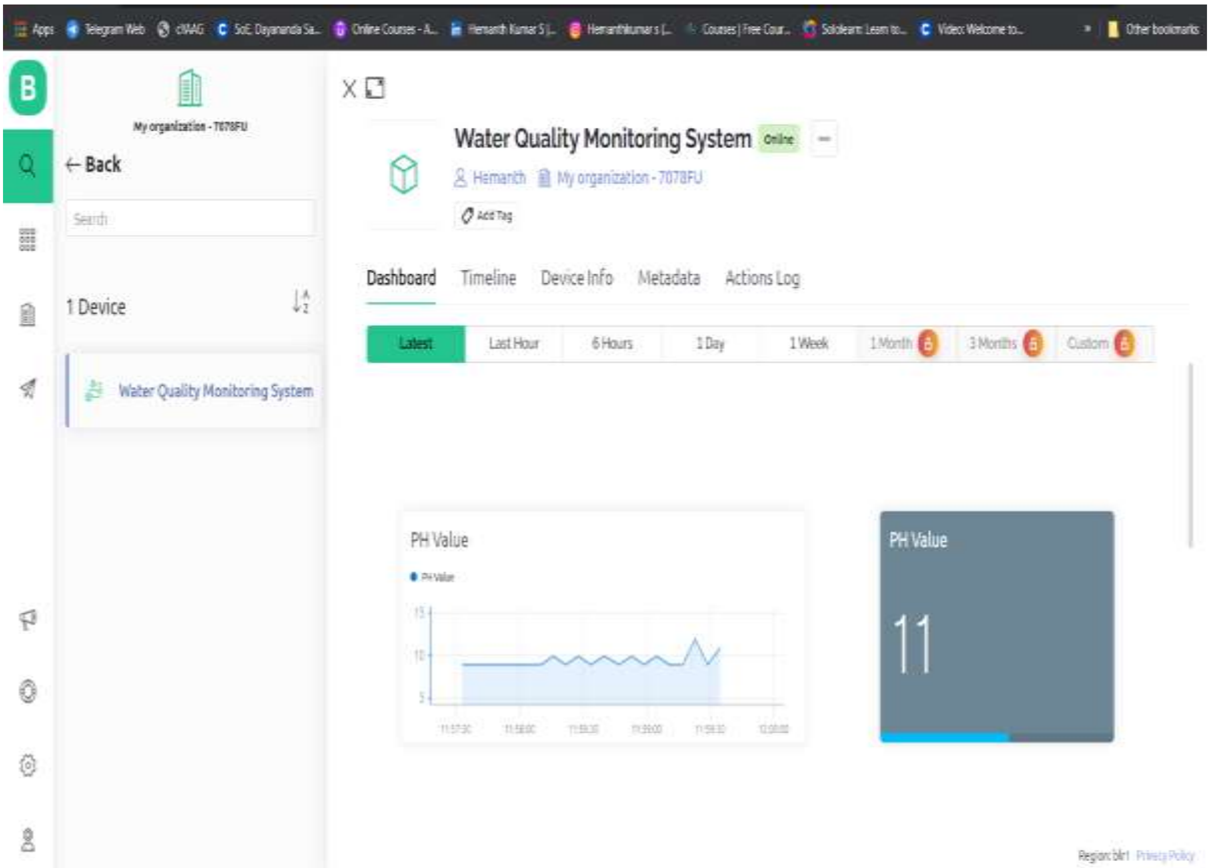

FIGURE 8.9: Web Interface Output of pH Sensor

We can visualize all the sensors output values in the form of data visualization,in graphical user interface . which in turn help the fish farmers can easily visualize the parameter values in the form of graphs, and if the values exceeds the normal values , they can easily monitor the values. This monitoring system of water quality for Aquaculture helps the fish farmers to be connected and live updates are given on observing changes in the parameter the fish farmer can take action and maintain the parameter and due to the notification setup in the system the farmer is immediately informed about the changes and no damage will be occurred.

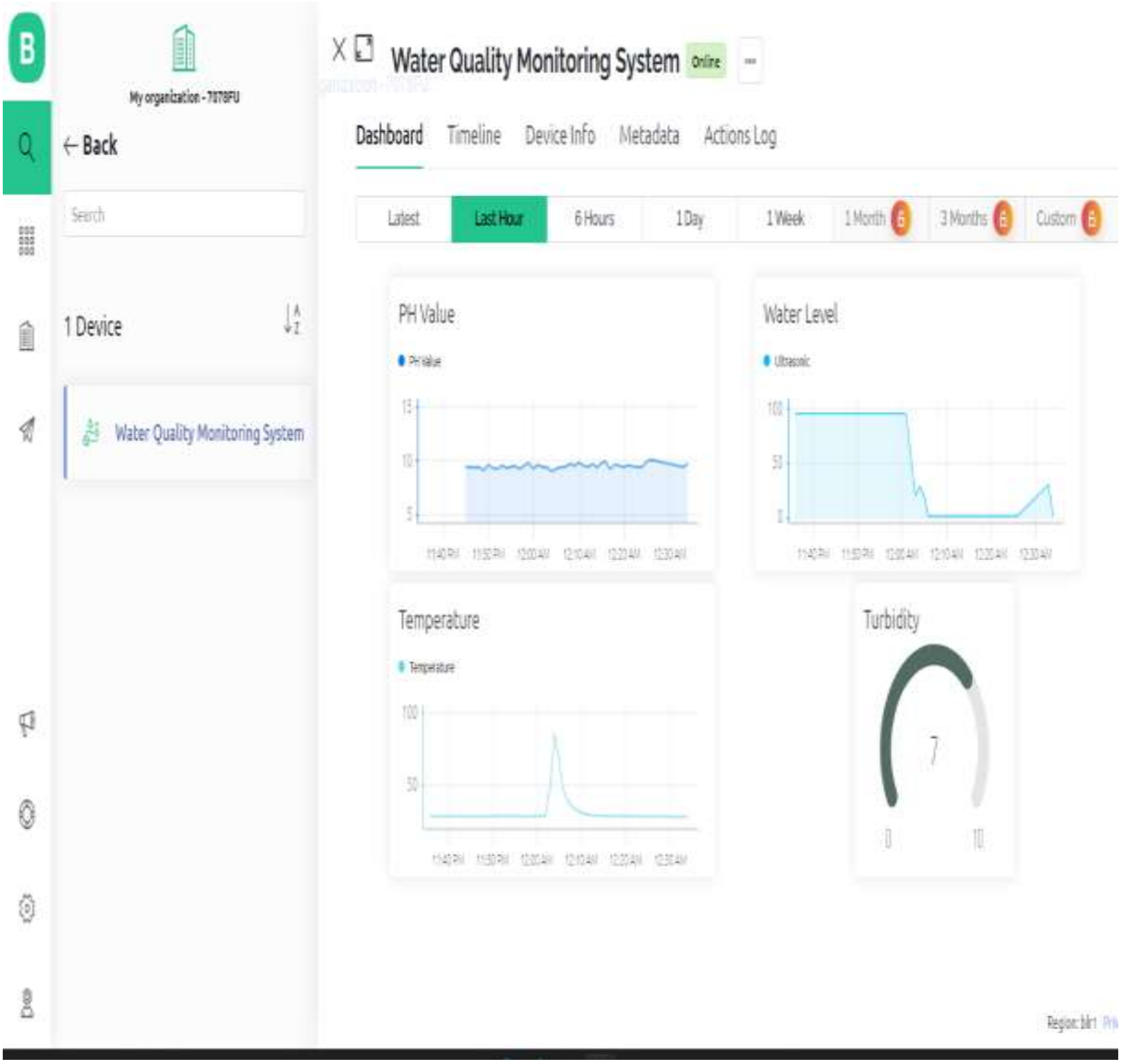

FIGURE 8.10: Graphical representation of all the 4 Sensors.

The Machine Learning application of water quality predictor helps us to classify the data as different classes based on the parameters of the water then try to enhance the accuracy level of prediction of the different classes of fish pond which helps immensely in cultivating the fish at every point of time.

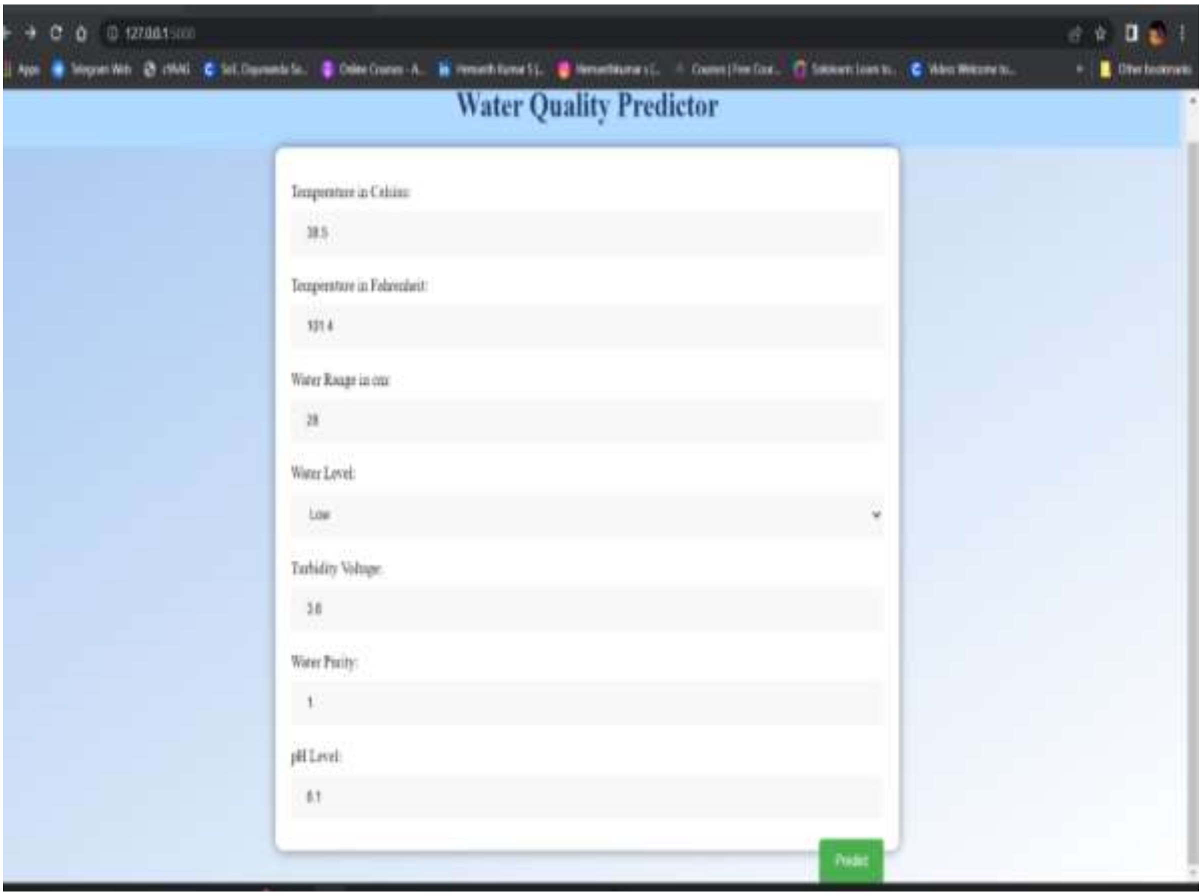

FIGURE 8.11: Output of Machine Learning Water Quality Predictor Application

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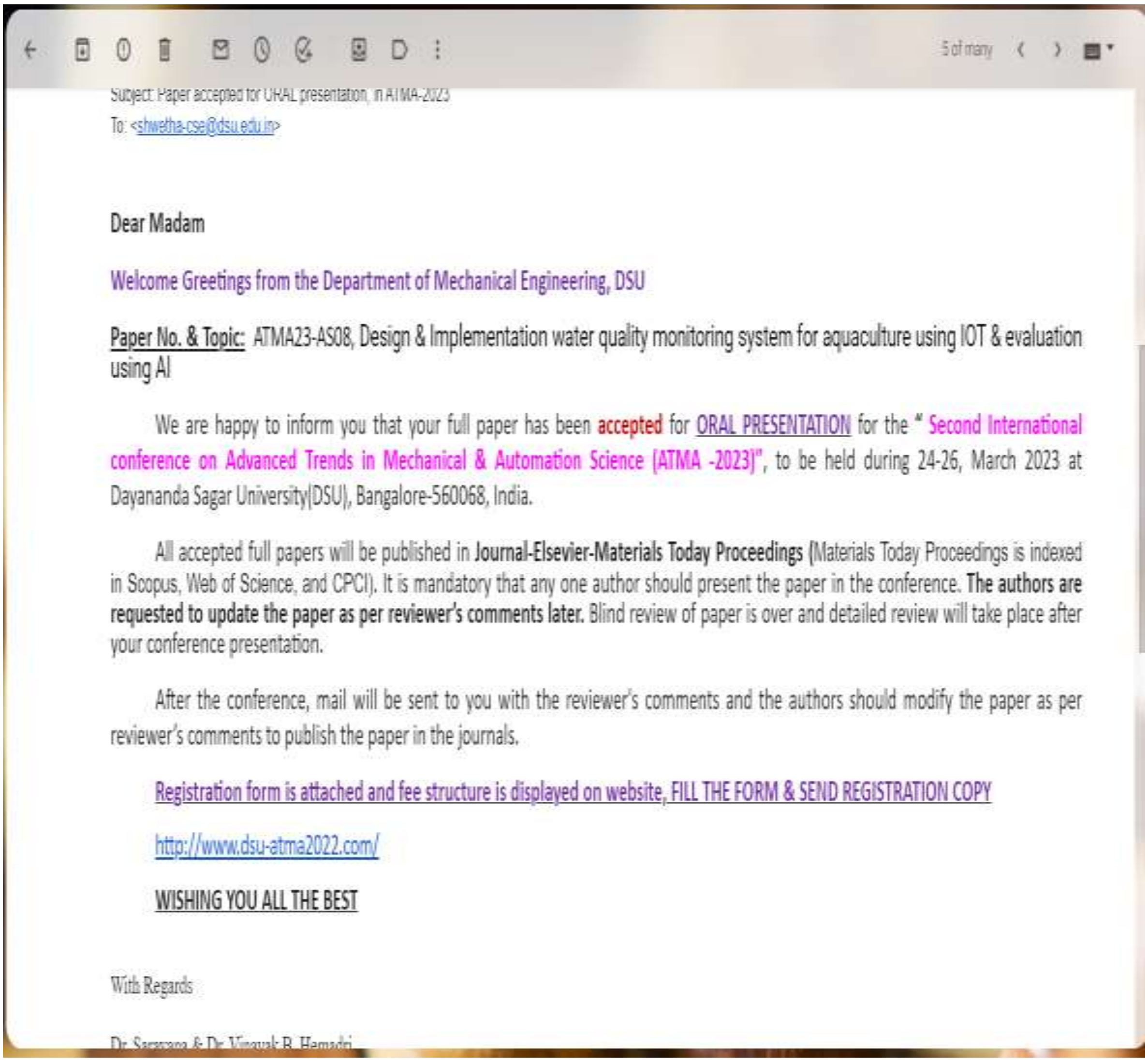
Published Paper details

Our team paper titled "**Design and Implementation Water Quality Monitoring System for Aquaculture using IOT and Evaluation Using ML"** has been accepted for the **" Second International conference on Advanced Trends in Mechanical & Automation Science (ATMA -2023)"**and the presentation has been done already.

All accepted full papers will be published in **Journal-Elsevier-Materials Today Proceedings (**Materials Today Proceedings is indexed in Scopus, Web of Science, and CPCI).



5 of many

Subject: Paper accepted for ORAL presentation, in ATMA-2023

To: <shwetha-cse@dsu.edu.in>

Dear Madam

Welcome Greetings from the Department of Mechanical Engineering, DSU

Paper No. & Topic: ATMA23-AS08, Design & Implementation water quality monitoring system for aquaculture using IOT & evaluation using AI

We are happy to inform you that your full paper has been **accepted** for ORAL PRESENTATION for the " Second International conference on Advanced Trends in Mechanical & Automation Science (ATMA -2023)", to be held during 24-26, March 2023 at Dayananda Sagar University(DSU), Bangalore-560068, India.

All accepted full papers will be published in **Journal-Elsevier-Materials Today Proceedings** (Materials Today Proceedings is indexed in Scopus, Web of Science, and CPCI). It is mandatory that any one author should present the paper in the conference. **The authors are requested to update the paper as per reviewer's comments later.** Blind review of paper is over and detailed review will take place after your conference presentation.

After the conference, mail will be sent to you with the reviewer's comments and the authors should modify the paper as per reviewer's comments to publish the paper in the journals.

Registration form is attached and fee structure is displayed on website, FILL THE FORM & SEND REGISTRATION COPY

http://www.dsu-atma2022.com/

WISHING YOU ALL THE BEST

With Regards

Dr. Saravana & Dr. Vinayak B. Hemadri

GitHub Link

This is the GitHub link of our project in which we have uploaded all the files of our project.

https://github.com/Hemanth-Kumar7855/-Design-and-Implementation-Water-Quality-Monitoring-System-for-Aquaculture-using-IOT-