Automated Aqua Farming Monitoring System

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Abstract: This is a monitoring system that helps us to improve sustainability and lower health and safety risks on modern fish farms. This will help us achieve the goal of making the fish farm more profitable and fit for the future. Water quality is the major issue in the aquaculture industry that includes turbidity, water level, temperature, pH values, etc. This can be an industry where we can make money from fish farming and it also helps us to preserve the environment without causing any harm by equipping the pond with a suitable device. The quality of the water needs to be continuously monitored as any deviation from the allowed critical parameters (temperature, pH) can cause unwanted scenarios such as stress, disease, higher mortality and which leads to a loss of farming. As this is an automated system that is capable of monitoring water levels, we have nothing to worry about since everything is automated and can be monitored closely just using a smartphone with an application. Our system will be able to monitor the parameters in real-time continuously. Using Arduino, we are planning to actualize monitoring of pond health continuously by adding various sensors like turbidity, temperature, and pH sensors, and using the data we receive we will be able to monitor the trends by creating reports with the help of MATLAB. Currently, most fish breeders monitor the process manually by using portable sensors, this requires a lot of manpower and also is time-consuming particularly in the case of large-scale industries. Hence, we are focusing on developing a simple, low-cost, and efficient aqua farming monitoring system for the fish industry.

I. INTRODUCTION

1.1 OBJECTIVE AND GOAL OF THE PROJECT

The aim of this project is to equip the water body with a suitable device that automatically reads the necessary parameters 24/7 using IoT technology. This system gives accurate readings without checking the parameters manually for every few hours, so it reduces the losses and saves the labor cost which is cost-effective. It is difficult to manage fish farms with traditional and non-technical methods. It mainly helps to provide nutrition for millions of people.

Maintaining the quality of the water quality is one of the important aspects that play a substantial effect on the aquaculture industry.

A user will be able to monitor the water condition using mobile through Wi-Fi within the Wi-Fi range. So, here we will be able to get a mobile notification in case of any change in parameters that is not normal.

Our system will also be able to monitor the parameter continuously with the capability of record and analyzing each reading in a more efficient way using the record things speak platform.

1.2 PROBLEM STATEMENT

With sudden climatic changes, the parameters of water keep changing and that can be an issue which we face. Most of the farmworkers are depending on manual testing which is a time-consuming process and might also give us inaccurate results as the parameters keep changing and might affect the fish in the pond and we can end up in a huge loss.

1.3 SOCIETAL IMPACT

Aquaculture is a rapidly expanding and dynamic economic sector but very minute changes in the parameters such as temperature, pH level, etc might increase the mortality rate of fish and result in huge losses. It can also result in critical conditions for fish which will be a risk factor if human beings consume such fish. Hence this system helps us take measures to maintain the proper environment for aquafarming. It helps us identify the problem beforehand and solve the issue which is an advantage for fish farmworkers.

It helps the economy as this system generates enough money to help provide funding. Millions of people throughout the nation consume fish. So with the help of this system, we can create a good amount of product with less wastage. Aquafarming is also important for bioproduct development. It also helps to protect aquatic environments as the area where the farms are placed must be free from pollution and garbage.

II. LITERATURE SURVEY

1. IoT Based Automated Fish Farm Aquaculture Monitoring System by SajalSaha, Rakibul Hasan Rajib, SumaiyaKabir (2018). In this paper, the authors have outlined and actualized monitoring of water quality of aquaculture utilizing Raspberry Pi, Arduino, various sensors, Smartphone Cameras, and android applications. Water quality parameters used in their work are Temperature, pH, Electrical Conductivity, and color. Android phone is used as the terminal device. By their project, a user can monitor the water condition using an android app through Wi-Fi within the Wi-Fi range and through Internet from anywhere in the world. In this paper, the authors have designed an IoT-based system for detecting temperature, pH, color and they focused only on the use of the live data that can be viewed on the Web application.

We get a few insights from the above paper, few of them are “it is not necessary to use separate sensors for every parameter. Instead, by using the sensor of one parameter we can estimate the impact of other parameters” ex: we know that DO (dissolved oxygen) is an important factor in aquaculture, but we don’t need to use the specific sensor for measuring DO instead by using Temperature sensor we can estimate the rise and fall of DO in water based on the fact that as the temperature rises the DO levels will get decreases and vice-versa. Also, the above-mentioned paper is dealing with the live data that can be viewed from a webpage, whereas in our proposed system we are planning to transfer the data obtained from the sensors to the cloud (ThingSpeak), thereby the data will be used to generate reports and graph. The data received to the cloud can be used to send alert messages to the farmer when the parameters reach the threshold values.

2. Sheetal Israni, HarshalMeharkure, Parag Yelore, “Application of IoT based System for Advance Agriculture in India,” in this paper they suggested IoT based sensor network for agriculture use. In India agriculture is mostly dependent upon natural resources and weather conditions. The sensors used here are the Soil moisture sensor, Soil temperature sensor, and pH sensor for soil. The wireless sensor network XBee is used to connect and the data will be conveyed to a station pc in the control room which will be updated on a website for easy access on a smartphone/ tablet. Here agricultural information cloud is constructed based on cloud computing and smart agriculture will be constructed with a combination of IoT and RFID.

The differences between the above-mentioned paper and our proposed project are soil farming and aqua farming. The sensors used in this paper are - Soil moisture sensor, Soil temperature sensor, and pH sensor for soil but we will be using temperature, turbidity, humidity, and pH sensors for detecting the water quality, the system can control the requirements from the data collected for different types of crops at different times of the year whereas we will be analyzing the future conditions of the water and retrieve graphs with the data collected. Here they will be able to access the data using a smartphone whereas our proposed system will only display a message about the water quality from time to time with which we can take necessary actions.

3. IoT-based Smart Agriculture Nikesh Gondchawarl, Prof. Dr. R. S. Kawitkar, in this paper they have mentioned smart agriculture, which aims at making agriculture smart using automation and IoT technologies. The highlighting features of this project include smart GPS-based remote-controlled robots to perform tasks like weeding, spraying, moisture sensing, bird and animal scaring, keeping vigilance, etc. Controlling of all these operations will be through any remote smart device or computer connected to the Internet and the operations will be performed by interfacing sensors, ZigBee or Wi-Fi modules, camera, and actuators with microcontroller and raspberry pi.

The main difference between this project and ours is, they are working on farm agriculture, we are working on aquafarming, they have considered moisture, weeds, and spraying as the basic function which is important to agriculture. We are focusing on the conditions of water like pH level, turbidity, and temperature which are a few important factors in aqua farming. In our proposed project, we will use sensors to detect the water quality whereas they used Wi-Fi or ZigBee modules, camera modules to detect weed. They are using GPS to collect the data into the cloud and we will be using Wi-Fi modules to send the data into ThingSpeak and retrieve it using MATLAB.

4. Knowledge-Based Real-Time Monitoring System for Aquaculture Using IoT, Raghu Sita Rama Raju, and G. Harish Kumar Varma. In this paper, they discussed how IoT can help aqua farmers for monitoring the water quality which plays a vital role in aquaculture. This proposed work uses an integrated-on chip computer Raspberry Pi which has an inbuilt Wi-Fi module that makes it unique. It is energized with the help of a solar panel which is more reliable and wireless. Several sensors are mounted to sense the data and the data will be transferred to the aqua farmer through IoT.

The main difference between the paper discussed above and our project is that they worked with Raspberry Pi but in our project we gonna use Arduino. In their work, they used different sensors to measure the Dissolved Oxygen (DO), PH, Ammonia, Salt, Carbonates (CO3) but here in our project, we used sensors to measure the PH, Turbidity, Temperature, and Humidity values of the water to check the water quality.

III. REQUIREMENT SPECIFICATION

3.1 Hardware Requirements

DTH11:

Power Supply: 3.3 - 5.5V DC
Measurement Range: Humidity 20 - 90% RH
Temperature: 0 - 50℃

Turbidity Sensor:

Working voltage: DC 5V
Working current: 30mA [max]
Response time: <500 msec,
Insulation Resistance: 100M [Min]
Operating Temperature (C): -30 to +80

pH Sensor:

Input Supply Voltage (VDC): 5
Measuring Range: 0 – 14 pH
Measuring Temperature: 0 – 50 ℃
Response Time: ≤ 1min

ESP8266:

Operating Voltage: 3.3V

Arduino UNO:

Operating Voltage: 5 Volts
Input Voltage: 7 to 20 Volts

Breadboard & Jumper wires:

Male-to-Female, Male-to-Male, Female-to-Female.

Relay:

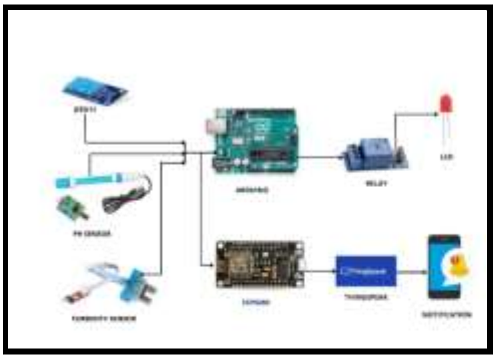
(1 channel), 5V DC, 100ma, Load - 250v 10a AC or 30v 10a dc

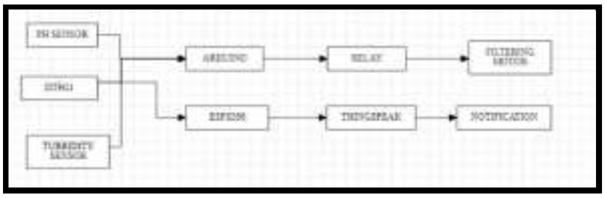
3.2 Software Requirements

Arduino IDE – 1.8.16 (recommended): The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. This software can be used with any Arduino board.
Central Processing Unit (CPU): Intel Core i5 6th Generation processor or higher. An AMD equivalent processor will also be optimal. RAM: 4 to 8GB min, 16GB or higher is recommended.
Operating System: Ubuntu or Microsoft Windows 10.
Python – 3.10.0: We used a Jupyter notebook for implementation – any PythonIDE is sufficient.

IV. SYSTEM DESIGN

The code provided in the appendix is implemented in Arduino IDE. Circuit is designed and we tried implementing the setup with soap water, pure water, and tap water and got the readings accordingly and sent the message to the user's device whenever required. The below-mentioned image and block diagram represent the total flow of our project with several modules involved such as the implementation of the model, implementation of code, interfacing hardware with software, analyzing and visualizing the data, and at last, sending a message to the device.





Dataset Used:
A Dataset for Monitoring Water Quality Using Digital Sensors (Size=9623)
https://data.mendeley.com/datasets/34rczh25kc/4
Contains readings of data from different sensors. (Customised)
Columns: Temperature, pH, Turbidity, Water quality.

V. IMPLEMENTATION OF SYSTEM

- The Aquafarming Monitoring System is designed to track pH, turbidity, and temperature, and humidity of water to maintain the correct environment for fish growth. The system will respond accordingly and send a message to the device describing the water quality.

- At first, each sensor - pH, turbidity, temperature, and humidity were tested individually to check if they are working fine.
- Then all three sensors are integrated with the help of the Arduino board which is programmed with the Arduino IDE. Here pH and turbidity sensors are analog sensors so, we connected them to the analog pins in the Arduino board(A0-A5) and the DTH11 sensor has been connected to digital pin 2 in the Arduino board using breadboard and jump wires.
- We took relay as the input to digital pin 7 and LED as the output in the Arduino board and coded the program using if conditions for all three sensors in such a way that the LED glows whenever the digital pin 7 reads high i.e., when the relay is triggered.
- Once this is done each sensor is connected to one ESP8266 which helps us to read and upload the real-time data from the sensors into the cloud platform - ThingSpeak. Here pH and turbidity are connected to the A0 pin and DTH11 to D4 pin in ESP8266.
- A channel is created in ThingSpeak and we created four fields namely pH, turbidity, temperature, and humidity to visualize the real-time data read from each sensor individually for which the field number of each sensor is mentioned in the code to visualize the particular sensor's data accordingly.
- To visualize this, we got the write API key from the channel that was created and added this in the code along with the WiFi name and password that we used at the time of implementation.
- We also have a module where a notification is sent to the user whenever the water quality is bad. For this, we used the IFTTT app where we used webhooks and android SMS services by giving if this then that conditions. We created five such applets for the conditions where the user will get a message to take necessary action according to the water parameter whose threshold value is not in the specified range. We also created a new Thing HTTP and a new react in ThingSpeak for the applet to work whenever the condition is met by giving the conditions and field names.
- We implemented two machine learning algorithms - Logistic regression and Naive Bayes for which we used a dataset taken from the Mendeley database. Here we pre-processed the data, and trained the model using the above-mentioned methods, and tested the model by taking a few output data that we got from the hardware implementation and displayed the output, whether the water quality is good or bad according to the given data with 90% accuracy in both the models.

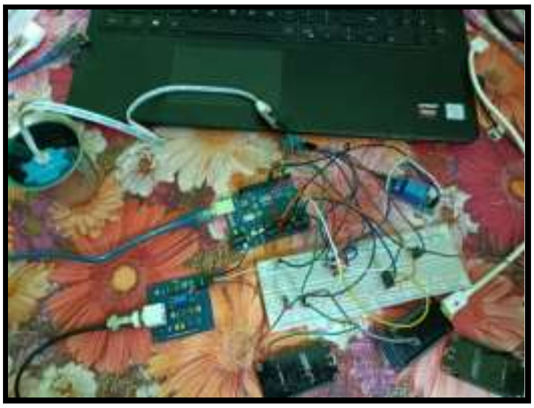


Figure 1: Final Circuit

VI. RESULTS AND DISCUSSION

1. Implementation of the model: In this module, we have identified the required hardware components and with the identified hardware i.e., DTH11, pH sensor, Turbidity Sensor, Relay, ESP8266, Arduino, Breadboard, LED we have implemented the model. First, we tried with individual sensors and then integrated them with each other using Arduino and then added a relay to trigger the led whenever the water parameters are not in the specified range. In the next module, we will be adding code that helps us to read the values and display the same.
2. Interfacing hardware with the software (Cloud database): After completing the implementation of code and model. The system is interfaced with the WiFi module to transfer the data obtained from the sensors to cloud storage - ThingSpeak. Here the circuit shown below consists of a WiFi module that is used to transfer the data that is obtained from the model.
3. Analyze and visualize the data: After sending the data to ThingSpeak, with the help of MATLAB, data is analyzed and visualized. Here we added four fields for all these parameters - pH, Temperature, Humidity, and Turbidity, and the graphs will be displayed the data stored here. We can do more such

visualizations here with the help of a few options that are available in ThingSpeak.

4. Message to our Device: In order to make it easy for us to keep a track of water parameters we added a feature where we get a message regarding the water quality to our mail id and to our mobile phone. So, the user will get a message and a mail whenever the water quality is bad so that they can take necessary actions based on the parameter.

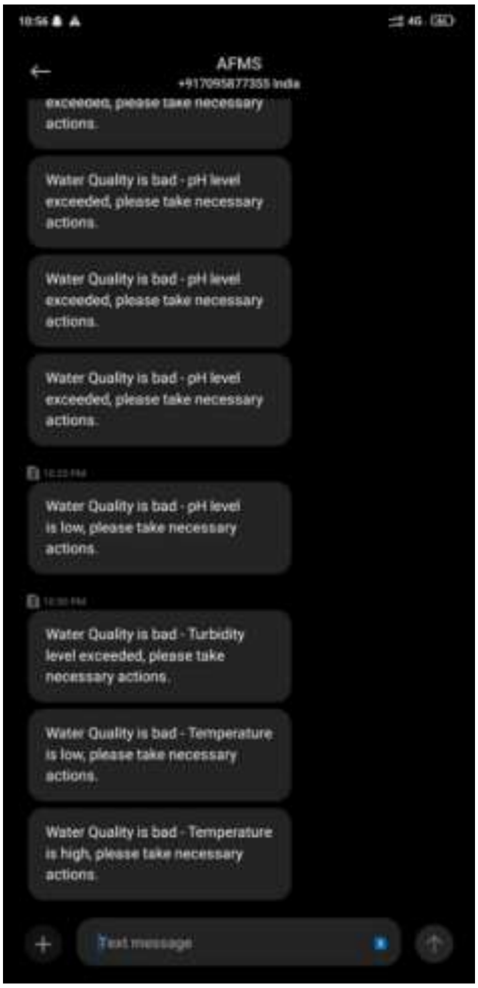
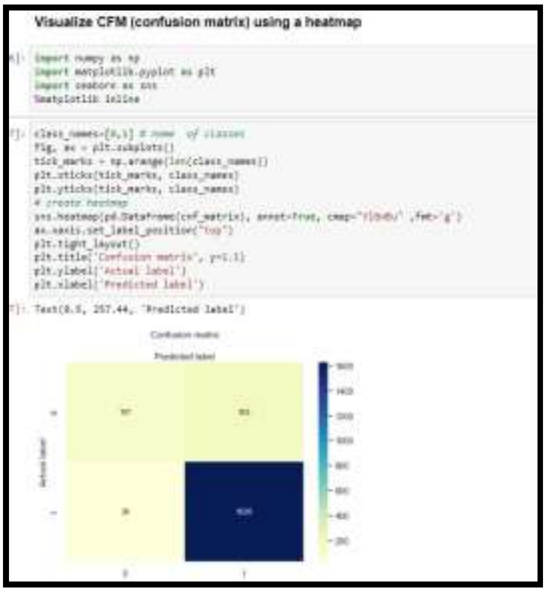
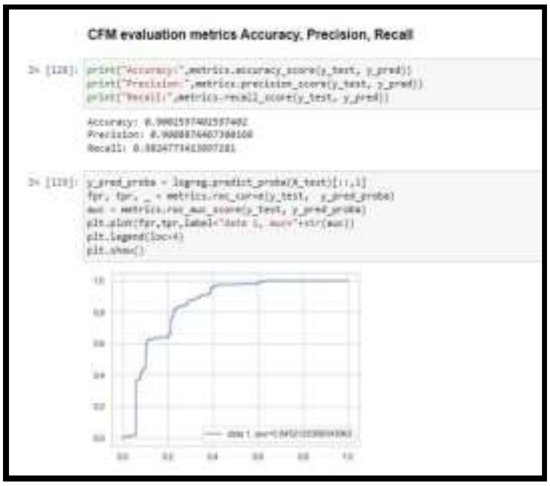


Figure 2: Notifications received by the user

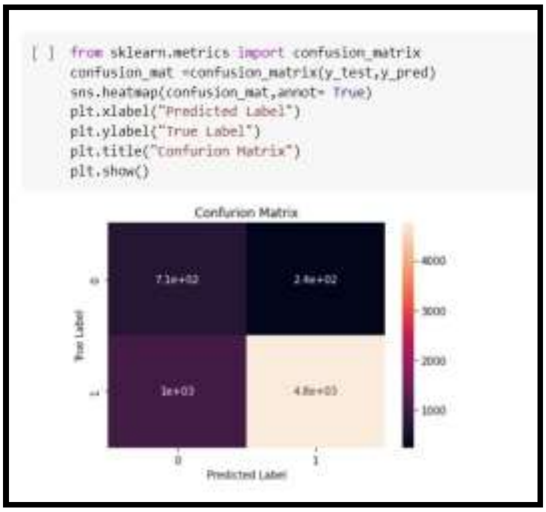
5. Predicting the water parameters using various ML models: In this module, various Machine Learning models are implemented and the output data obtained from the sensors is used to test, and available data(dataset) is used to train the model. With this, we can predict the water parameters for future purposes. Here we used Logistic Regression and Naive Bayes algorithms to train and test the data set and displayed whether the water quality is good (1) or bad (0).

Logistic Regression:





Naive Bayes:



VII. CONCLUSION AND FUTURE WORK

This project helps the aqua farmers to monitor the water parameters accurately because manual testing can be time-consuming and the parameters may alter with the time being, it also helps to take necessary proactive measures before the damage is done. Though the initial cost is high, there will be no additional costs for maintenance after the installation is done. It saves time and energy as there is no need for a person to test the water parameters manually. Thus, IoT has reached the farmers for reducing the risk from climate changes and ensures the growth and health of aqua life. The increase in productivity helps in increasing foreign trade. In later stages, the collected data can be used to analyze using big data analytics and preventive measures can be taken before any parameter crosses the threshold range. Though we implemented machine learning algorithms we didn't give any connection with the data that we read from the sensors, hence we would like to implement that as future work and detect the water quality accordingly. Using IoT we can reduce both the energy consumption and labour cost by making the aquafarming system automated.

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