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Smart Aquaculture Using Data Mining

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Abstract: ***The common method of water quality testing is to collect samples manually and then send them to laboratory for analysis. However, it has been unable to meet the demands of water quality monitoring today. So, to overcome this problem we have made this system. Aquaculture is the breeding or farming of aquatic organisms in a climate-controlled environment. Aquaculture involves breeding freshwater populations under controlled and continuously monitored environment. Water quality is a crucial factor while breeding aquatic organisms. The System continuously monitors the quality of water with the help of various sensors. The sensed data is transferred to the cloud and then to the end user. The sensed data is viewed by the user with the help of an Android application and provide relevant suggestions to the user.***

Keywords: IoT, Data Mining, Node MCU, pH Sensor, Turbidity Sensor, Temperature Sensor, Water Quality Monitoring

I. INTRODUCTION

Aquaculture is the breeding and harvesting of fish, shellfish, algae and other organisms in all types of water environments. It is one of the growing sectors in India as it makes up nearly 1.1% of GDP and 5.15% of agricultural GDP. India's aquaculture economy is booming as it has achieved second place in fish production in the world. It is estimated that fish requirement of the country by 2026 would be about 18 million tonnes. But due to the introduction of commercial aquaculture natural fisheries have been depleted. Aquaculture is also facing many hurdles due to sudden climate changes. At present aqua farmers use outdated techniques for testing the water quality. This would be inaccurate because water quality parameters are unstable and may vary with time.

To overcome this problem, more and more technology should be brought to aqua culture which increases the productivity and minimize the loses by constant monitoring of water quality parameters. The proposed work uses a node MCU. Several sensors such as temperature, pH and turbidity are mounted on the node MCU to sense the data which is then transferred to the aqua farmer through a cloud on an Android app using IoT. There are some threshold values of water quality parameters for fish culture. A dataset is created of the parameters on which data mining algorithm would be applied to classify different problems and provide relevant suggestions to the farmer.

The advantages of this method are unhygienic environmental conditions can be determined and preventive measures can be taken immediately. This is reliable and reduces the risk of aquatic life.

II. LITERATURE REVIEW

In [1] authors have describe an automatic system which will check the characteristics of water of aqua ponds in any situation. The system checked with various sensors record also saves the entire measured data in a database and it will provide analysis of data by using analyzed patterns of changing environmental conditions in the fish ponds. That information will be compared with preset ideal conditions. If the data from the monitoring system is outside a preset range than the system will alert the user to take suitable actions of precautions.

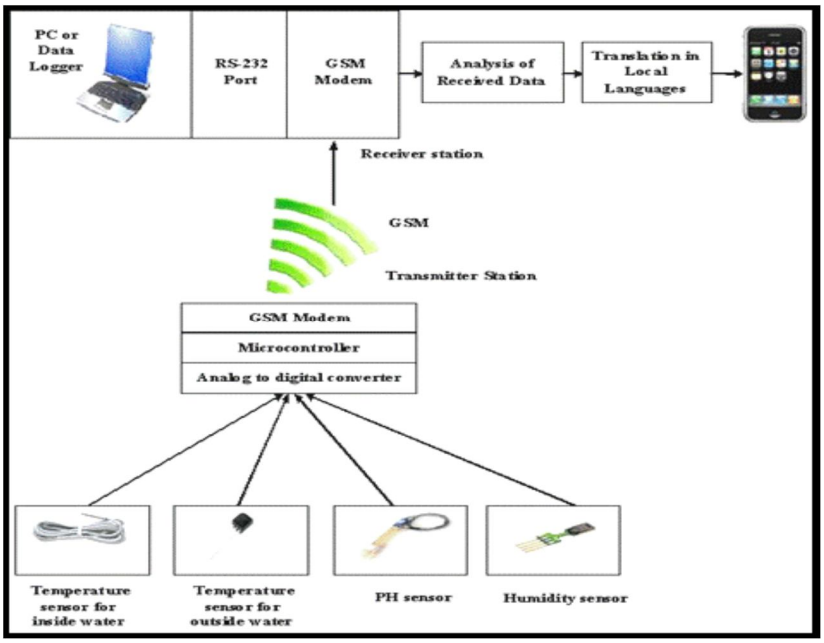

Fig. 1: Architecture diagram of Design and Deployment of Aqua Monitoring System Using Wireless Sensor

In [2] authors had propose real-time monitoring of the water quality with the help of IoT. Different parameters of water will automatically get detected under the control of single chip microcontroller everyday. The chip processes and analyzes the data and then it is sent to the monitoring center by GSM network in the form of SMS. After that the management and the monitoring center will assess the water quality and detect real-time solution of water quality remotely.

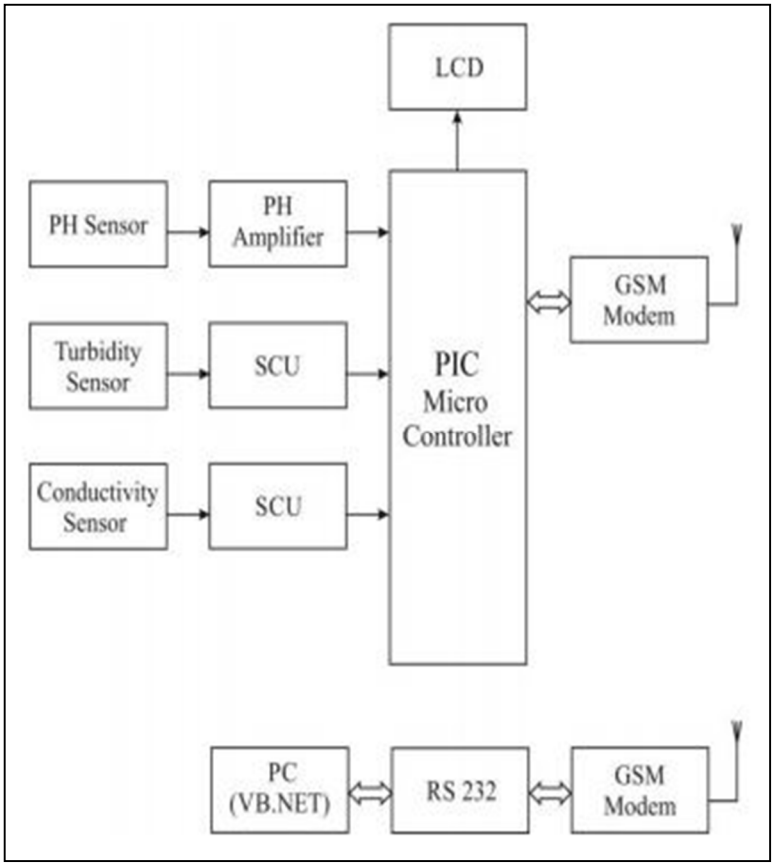

Fig. 2: Architecture diagram of GSM Based Automatic Water Quality Control Analysis

In [3] the system allows a user to monitor and control the aqua farm environmental data and using a mobile device. MCU processing is used to capture the physical sensing signal. The ZigBee wireless sensor network brings the data to a central processing core unit. A WIFI interface transfers the data to the user terminal device. The user can control the entire aqua farm environment through the terminal device with an Android app made for this purpose.

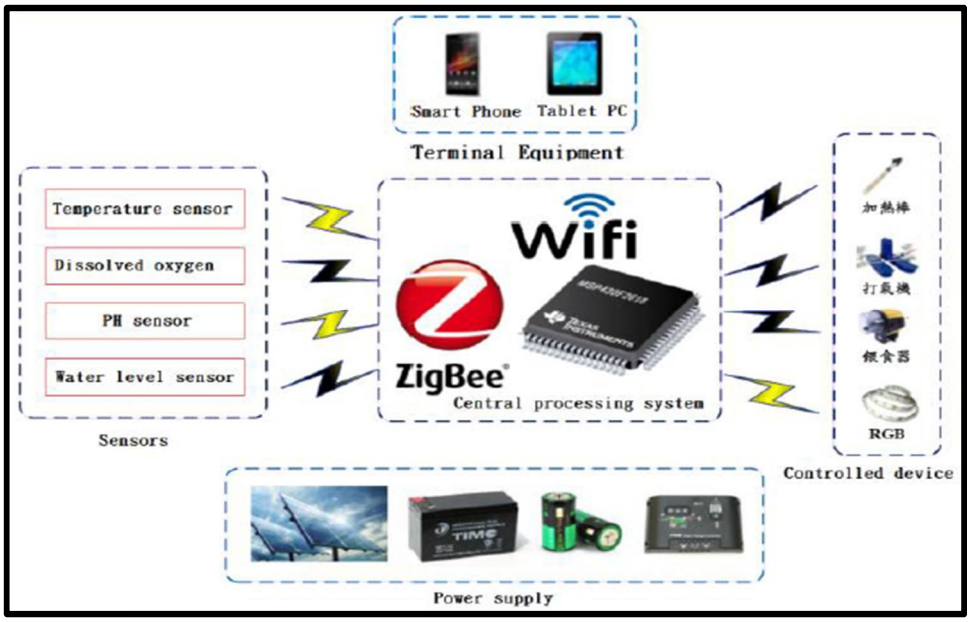

Fig. 3: Architecture diagram of Automated Monitoring System for the Fish Farm Aquaculture Environment

III.PROPOSED IDEA

In our system we are using Node MCU, an Android phone, Cloud Service, and various sensors such as Temperature sensor, pH sensor and Turbidity sensor. Sensors will continuously monitor the environment of aquaculture. This system will update the readings on the cloud server (such as AWS) and the server will keep a log of it. End user applications such as WebApp or Android app will display the real-time readings to the user and provide relevant suggestions to the user. The user can also set reminders for reminding the user to change and clean the water. The user will also receive warnings about the water condition if the readings fall below the critical level. The system will also notify and control the water temperature so as to maintain the temperature favourable for aquatic creatures.

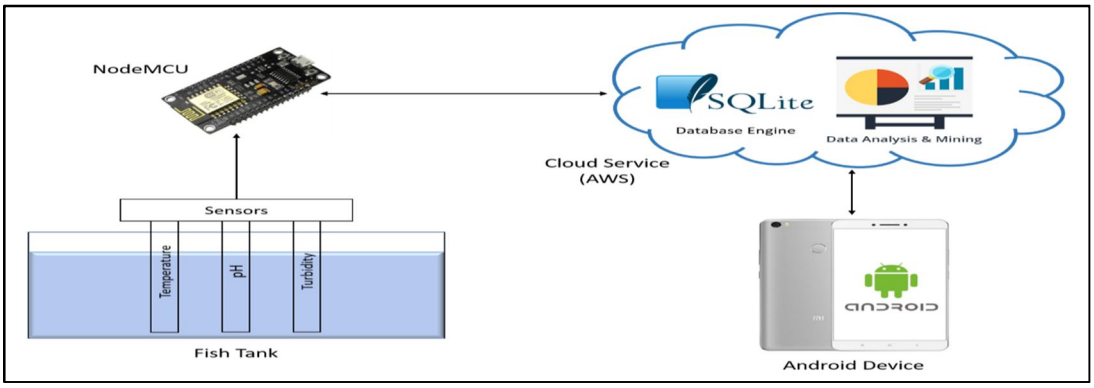

Fig. 4: Architecture diagram of Smart Aquaculture

A. Hardware Unit

In our system, we are using three sensors, which are Temperature, Turbidity and pH Probe. The Temperature sensor (DS18B20) is a submersible sensor. The Turbidity sensor (TSD-10) is used to check the opaqueness of the water i.e. how dirty/muddy the water is. The pH Probe checks the alkalinity of the water. These sensors continuously monitor the water quality of the given environment with the delay of 1 minute (defined by us). The readings are then sent to the NodeMCU (ESP8266), which is a microcontroller unit distributed by Espressif Inc. The NodeMCU then pushes the data to server through HTTP Post.

B. Software Unit

After the readings from the sensors is received, the Python program on the server (created on AWS-Amazon Web Service) saves the data in SQLite Database with a unique timestamp. The readings are provided to the user's Android app whenever needed. According to the data received, appropriate suggestions in favour of improving the water quality will be displayed to the user. Additionally, data mining is being implemented. We are using Curve Fitting (Non-linear Polynomial Fitting) to predict the future data. This data will only be provided when the user wishes to know the future condition/quality of water.

IV. IMPLEMENTATION

Initially, we have to gather a large dataset to train the Curve Fitting algorithm. This is an important step so as to produce near-to-accurate predictions.

A. Working of System to Perceive And Predict the Water Quality

1) Place the sensors in the water which is to be monitored.
2) Perceived data is then sent to NodeMCU.
3) The NodeMCU then sends the data to server.
4) The server then stores the data in the database with timestamp.
5) User starts the Android app.
6) The user requests for the readings.
7) The server fulfils the request by sending the data.
8) The user then enters a specific date and time to perform the prediction.
9) The time and data are then sent to the server by the Android app.
10) After receiving, the Non-linear Polynomial Fitting function executes and provides the predicted values.
11) These values are then sent to the user's Android app.
12) After the values are sent, the app will display the readings with appropriate suggestions, which will be pre-defined in the app.
13) A curve of the analysed data will also be displayed.

V. METHODOLOGY

Non-linear Polynomial Fitting which is also known as Curve Fitting is the process of developing a curve or a mathematical function which has best fit to a series of coordinates. These fitted curve is also used for data visualization and summarization between two or more variables. The following equation defines the curve model: $y[i] = f(x[i], a_0, a_1, a_2, \ldots)$ where $a_0, a_1, a_2, \ldots$ are the parameters. This equation will help to gain the function for the dataset of a year. After that, it will replicate itself for another year. We have three main parameters (temperature, turbidity and pH) and we are making a function by calculating these parameters w.r.t timestamp (UNIX Epoch Time) using the above equation. This equation will provide the values as per the input provided by the user.

VI. CONCLUSION AND FUTURE WORK

The detection and prediction of water quality in our system is completely autonomous, once it gets installed. This system helps the aqua farmers to monitor its aquafarm without performing any tedious testings or tasks and also obtain near-to-accurate readings as compared to manual testing. In future, more features can be incorporated in this system such as adding a Feeder, which can be controlled with the help of stepper motors. This feature can help the user to pre-define the timings for feeding the aquatic organisms so as to reduce the human workforce.

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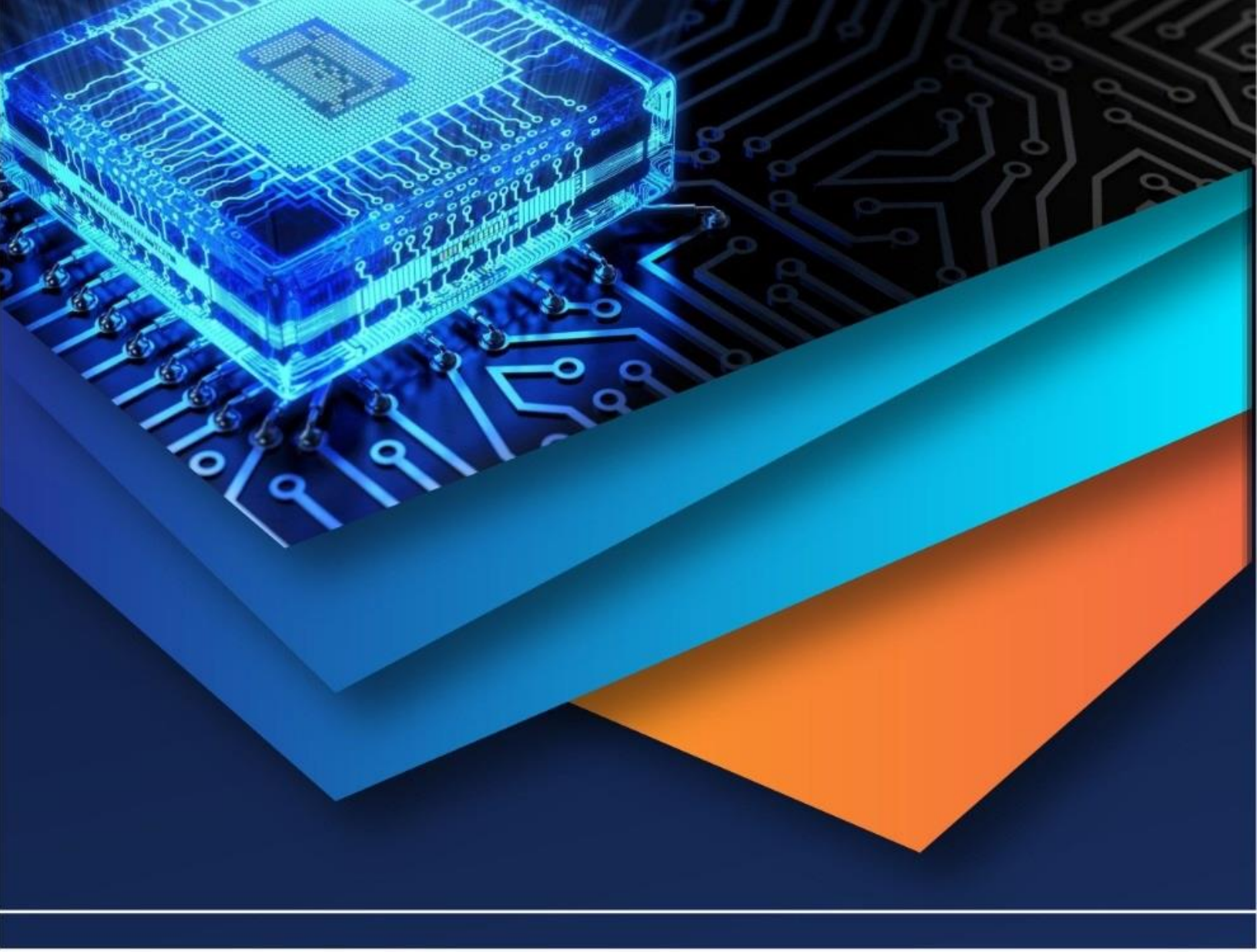

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