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Aquaculture monitoring and control system: An IoT based approach

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ABSTRACT

Internet of Things (IoT) is one of the rapidly developing fields for giving social and financial points of interest for rising and creating an economy of the nation. Presently IoT field is flourishing in areas like medical, agriculture, transportation, training, etc. This is of most importance because of aquaculture is a backward region of applied science. Contrasted with other zones like agriculture, consequently, it's essential to determine the issues that are in this area with the assistance of technology. Water quality might be a basic issue, it mainly depends upon numerous parameters like dissolved oxygen, carbonates, turbidity, ammonia, nitrates, salt, pH, temperature, etc. The proposed system continuously monitors the water quality parameter using sensors, the detected information is conveyed to the aqua-farmer mobile via the cloud. Accordingly, actions will be taken in time to reduce the losses and improve productivity. Among the issues, the slow latent period within the care of water quality, and therefore the wastage of resources like water, in cultivation are the necessary problems has to be addressed. The proposed system monitor the aquarium and uses the waste water from the aquarium to grow the plants, in turn, the pH and ammonia neutralized water from hydrogen clay pellets in grow bed is fed back to the aquarium.

Keywords— *Aquaculture, Machine to Machine (M2M) Connectivity, Round Trip Time (RTT)*

1. INTRODUCTION

Aquaculture is one of the prospering segments in developing countries like India as it contributes 1.07 percent of the GDP. It is found that fish necessity of the country by 2025 would be in terms of 1.6 crores tones and due to the overfishing regular fisheries have been drained therefore commercial aquaculture has been appeared. Aquaculture comprises the arrangement of exercises, information and methods for the rearing of underwater plants and a few types of animals in the water. This action has incredible significance in monetary advancement and food development. Constant checking of the physical, synthetic and organic guideline of lake or pond water helps not only to identify and control the negative states of aquaculture yet additionally to maintain a distance from natural harm and the breakdown of the production process. The observing of physical and substance factors like pH, oxygen, and temperature in water is crucial to keep up sufficient conditions and avoid unfortunate circumstances that cause the failure of aquaculture. Aquaculture, known as aquafarming, is the farming of aquatic animals, for example, scavengers, fish, and crabs. The proposed work supports remote observing of the fish farming dependent on Internet of Things (IoT) for ongoing checking, control of a fish farming and the serious issue like wastage of water in aquaculture are controlled with aquaponics, also called the coordination of hydroponics with aquaculture, has developed to be a fruitful model of feasible natural and organic food production. The harmonious connection between fish, plants, and microscopic organisms, in a controlled domain, relies on ideal water quality conditions. This requires a need to create consistent water quality checking procedures that depend on keen information securing, communication, and handling. This work centres around utilizing the Internet of Things (IoT) technology to screen and control of water quality parameters utilizing sensors that give remote, persistent, and continuous data of pointers related to water quality, on a graphical user interface(GUI). A designed work containing a Raspberry Pi 3 and commercial sensor circuits and tests that measure pH, water temperature and turbidity was conveyed in an aquarium and the data gained from the sensors is transferred to ThingSpeak, an IoT investigation stage service that gives continuous information representation and examination. Consistent observing of this information, and making vital modifications, will encourage the maintenance of a healthy environment that is conducive to the development of fish and plants while using around 90 percent less water than conventional farming.

2. OBJECTIVE

As of late commercial aquaculture is facing numerous challenges because of abrupt environmental condition variations that end up in changes in water quality parameters. As of now, aqua-farmers use manual check strategies for knowing the parameters of water. This will take longer and not correct since water quality parameters could change with respect to time. In order to avoid this downside, innovation should be involved in aquaculture that improves the potency and limits the losses by constant checking of water quality parameters. The goal of this project is to design and execute a distributed system for aquaculture water quality care through remote observing of turbidity, temperature and pH. This work will contribute remote monitoring framework through IoT to screen water quality in ponds. The system is portable, modular, low cost, versatile and permits sharing of data through the cloud that can be used for the advancement and improvement of aquaculture related activities.

3. RELATED WORKS

Some articles use Arduino a small controller for watching the aqua field [1], however, Raspberry Pi-3 is a lot more advanced compared with Arduino because it has intrinsic Wi-Fi module. Several papers focus on few kind sensors like turbidity, DO, pH, [2], [3], [4], etc., and a solution to those issues. However, the expansion of aquatic life depends on several constraints like Ammonia, Carbonates, Nitrate, Bi- Carbonates, Salt, etc. All the above parameters are measured with the help of several sensors and a possible solution was given to the aqua farmer to maintain the pond. The continuously detected information is sent directly to the aqua farmer through app [5], [6], [7]. Recently IoT is reaching top level with its application to farmers [8], [9]. many papers in literature survey focus on how actually the aquatic life get distracted because of modification in water quality parameters with respect to time, and how IoT technology is employed to overcome the problems [10], [11], [12]. Moreover, sending and storing the information in the cloud helps user for analyzing the data by data analytics, which might facilitate us to take pro-active measures before the modification in water quality parameters [14]. the above-designed system is energized with the assistance of municipal electricity with battery. However, aquafarmers face power cuts and this problem has to be addressed [15]. Our proposed model will give a solution to the aqua farmer before the damage was done to the aquatic animals and aquafarmer will get an alert message if the parameters of the aqua pond exceed the specified threshold range.

4. IOT BASED AQUACULTURE MONITORING AND CONTROL SYSTEM (IAMCS)

The proposed model predominantly centres on continuous observing the water quality factors at all time in order to take preventive steps early to harm for water animals. The proposed architecture has 4 parts, (1) power module, (2) sensor module, (3) controller module, (4) output module. The detailed block diagram of the framework is in figure 1.

4.1 System Features

The work is concerned with three major issues Effective measurement of water quality parameters, Monitoring, Control and Ease of access.

(a) Effective measurement of water quality parameters: The project has the sensor module includes a few sensors, for example, Turbidity, pH, Temperature, Salt, These sensors are fixed on Raspberry Pi and are used for detecting the water parameters all the time.

(b) Monitoring: The sensor data has been monitored using the thing speak cloud.

(c) Control: Based on the sensor data and threshold values the aqua pond can be controlled.

(d) Ease of access: The data can be effectively accessed using the cloud and it can be observed and controlled using the mobile application.

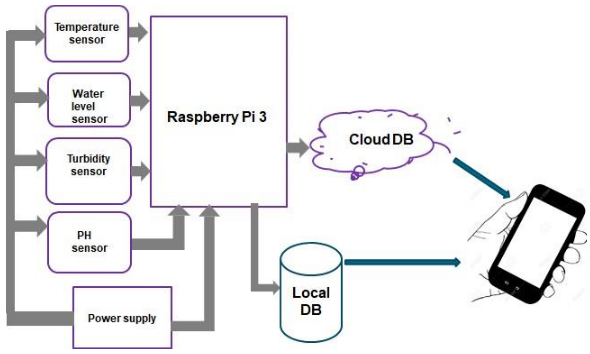

Fig. 1: Block Diagram of IAMCS

4.2 Block Diagram Description

4.2.1 Power module: The power module has a DC-DC converter, charge controller, battery. The battery is predominantly used to supply control in the night as water quality parameters for the most part changes at night. A DC-DC converter is there to give the capacity to scale controller module which will work at 5V. A DC-DC converter is mainly used to provide an invariable voltage.

4.2.2 Sensor module: The sensor module consists of certain sensors, for example, pH, turbidity, water level, Temperature. These sensors are connected with Raspberry Pi and are used for detecting the water parameters from time to time.

4.2.3 Controller module: It is treated as the most important part of this project. Raspberry Pi-3 model B is used as a controller. Raspberry Pi is a low budget, small computer board with Linux as a working framework. It has a large number of favourable circumstances when contrasted with other small scale controllers, for example, inbuilt Wi-Fi module. The Program for getting the sensor information is written in the python language and send that information to the cloud. The server-side program constantly onlookers the sensor esteems whether they are inside the edge extend. In the event that the qualities go amiss from the edge extend, telling message with the arrangement is sent to the mobile app that is an output module.

4.2.4 Output module: Aquafarmer mobile is treated as an output section. An app has been developed in the mobile phone which has several widgets to display the sensor data and other buttons to control the flow of water through the motor and if the sensed data exceed the threshold ranges alert Message will be sent to the farmer with necessary steps to be taken.

5. IMPLEMENTATION

The implementation of the entire system is categorized in terms of Hardware and Software. Once the hardware part is assembled that is sensor nodes with Raspberry Pi, comes the software part. Implementation is done mainly three different domains - Python, Cloud and Android. ThingSpeak is used for implementing cloud operations. Android App is developed using Android Studio. Raspberry Pi uses Raspbian as an Operating System (OS) and Python IDLE is used for writing Python codes. In addition to these, Putty and vncserver are also used for accessing the Raspberry Pi terminal from a laptop without connecting Raspberry Pi to monitor and separate keyboard and mouse. The communication mechanism between different nodes is based on I2C or SPI protocol. SPI (Serial peripheral interface) is a connectivity protocol for the machine- to - machine (M2M) communication. It was designed as transportation of extremely lightweight messaging and publishing. It is beneficial for remote location interconnections where a small code footprint is required and there is limited network bandwidth. The System uses ThingSpeak API as a key with URL to send the data from python IDLE. It can post messages after a ThingSpeak client is connected to a broker. ThingSpeak has a topic - based clarification of the broker's messages, so each message needs to contain a particular subject that the broker will use to send the message to active clients. Normally, each message has a payload containing the actual data to be transmitted in byte format. ThingSpeak is data-agnostic and the structure of the payload depends entirely on the use case. If you want to send binary data, textual data or even full-fledged XML or JSON or CSV, it is completely up to the sender. The Sensor hub, Cloud and end User Device all comes into picture while acknowledging in a consecutive way. Most importantly, information caught by the sensor hub is sent to the cloud and furthermore the end User. In the cloud, getting information is controlled and diverse errand is performed which are altogether clarified as the flowchart.

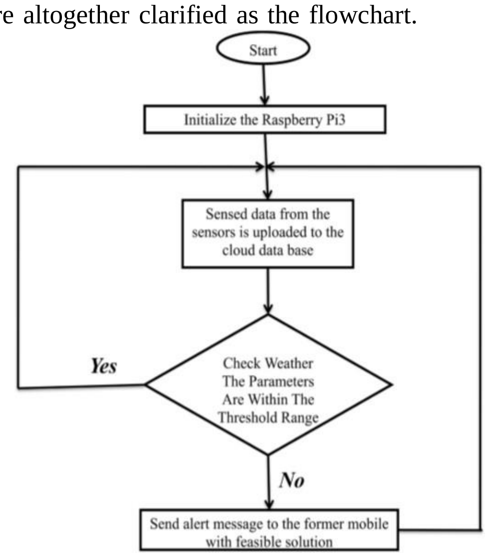

Fig. 2: Flowchart for IoT based aquaculture monitoring and control system

Figure 2, shows the series of exercises in the IAMCS. At the point when the web association is set up, it will begin perusing the parameters of various sensors. The edge levels for the required sensors are set. The sensor information is sent to the distributed storage just as the end client. The information can be examined down anyplace at any time. On the off chance that the sensor parameters are more than the limit level, at that point, the particular caution will be raised, and the end user is notified with an alert. The user is able to see values coming from the sensor node, and also remotely control the home appliances. Initially, Raspberry-pi has been powered on with 5V DC battery. Then all the sensors were interfaced and measure the respective values using the controller, then the measured values and threshold values are compared to provide a solution to the aqua farmers.

6. RESULT

In an aqua-pond, the proposed system was implemented and results were obtained using different sensors for 24 hours. Results were obtained with time for varying parameters of water quality. Figure 3 shows the plot of turbidity varying with time, the turbidity value crosses the edge value limit during that particular time interval, and the farmer will receive an alert message to enter fresh water to the pond. Similarly, Fig.4 and figure 5 show the variation of pH value with time and the variation of temperature with time.

Round-Trip Delay time (RTD) or The Round-Trip Time (RTT) is that the distance of amount it takings for a data to be sent and the length of your time it takes for associate degree salutation of that data to be received. This time postponement so consists of the propagation times between the 2 points of a symptom. To calculate RTT, two python codes run: one publisher and one subscriber, for different QOS Publisher, send a time-stamp of the moment it is sent as the message and the subscriber prints the time-stamp of the sent as well as the received message. The difference between the received and sent time-stamp to give the RTT. The RTT for different QOS is observed to be different. The RTT is maximum for QOS-2 and minimum for QOS-1.

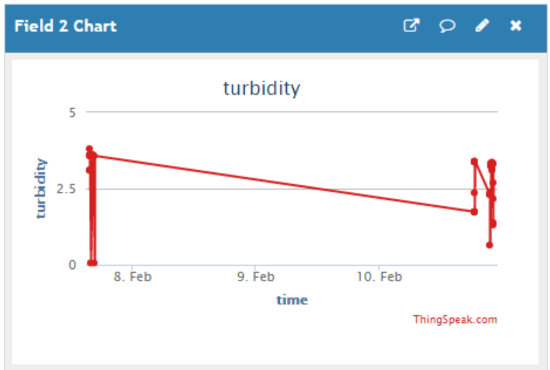

Fig. 3: Variation of turbidity with time

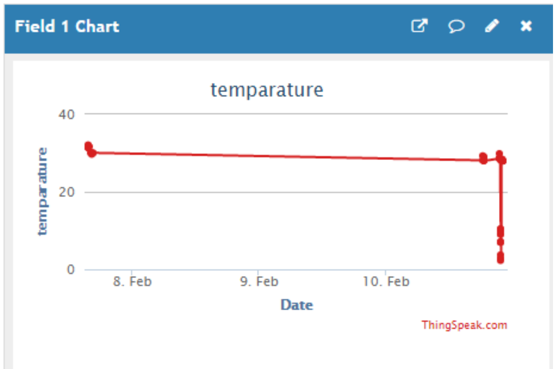

Fig. 4: Variation of temperature with time

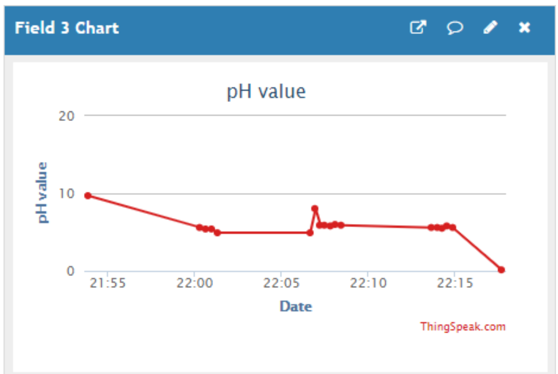

Fig. 5: Variation of pH with time

Table 1: Plot of RTD for different QOS

	Different QOS		
	QOS-1	QOS-2	QOS-3
Round Trip Delay Time (RTD) In Seconds	0.300381	0.351937	0.987955
	0.276321	0.309702	1.11196
	0.298737	0.338293	0.913541
	0.307348	0.312028	0.906115
	0.299203	0.305806	0.925123
	0.309988	0.303237	0.922354
	0.303936	0.453029	0.980266
	0.295921	0.487394	0.930914
	0.291621	0.753097	0.866448
	0.322207	0.310773	0.913768
	0.35289	0.330946	1.000624
	0.294583	0.307151	0.873627
	0.269409	0.325329	0.962085
	0.30185	0.389047	1.168426
	0.314331	0.325641	0.91456
	0.291204	0.314614	0.929088
	0.277165	0.312098	0.896656
Average RTD	0.30041735	0.36647776	0.953147647

Table 1 consists of various RTT obtained during the transmission of a message with different QoS. It also shows the average RTT for each QoS. The table data is latter plotted to obtain the graph shown in figure 6. Figure 5. Variation of temperature with time

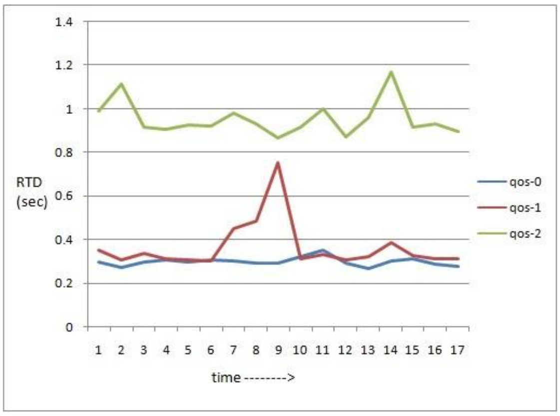

Fig. 6. RTT for different QOS

7. CONCLUSION

The methodology executed can facilitate the aqua-farmers for the precise and reliable observance of water parameters, the actual fact that manual testing will take longer and water quality parameters could change with time It additionally takes pro-active measures before any harm was done. Despite the fact that the primary cost is high, there will be no extra expense and maintenance once it is installed. Thus, the framework implemented will reach the farmers for reducing the harm from climatic changes and confirms growth and health for aquatic life. This improves productivity, helps in improving foreign trade and increases the GDP of the country. More the gathered information can be inspected utilizing big data analytics and necessary steps can be taken before the water quality parameter crosses the edge value range. The aqua- system automated using IoT, decreases the energy labour cost and consumption.

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