Knowledge Based Real Time Monitoring System for Aquaculture Using IoT

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Abstract— **Internet of things is one of the rapidly growing fields for delivering social and economic benefits for emerging and developing economy. The field of IOT is expanding its wings in all the domains like medical, industrial, transportation, education, mining etc. Now-a-days with the advancement in integrated on chip computers like Arduino, Raspberry pi the technology is reaching the ground level with its application in agriculture and aquaculture. Water quality is a critical factor while culturing aquatic organisms. It mainly depends on several parameters like dissolved oxygen, ammonia, pH, temperature, salt, nitrates, carbonates etc. The quality of water is monitored continuously with the help of sensors to ensure growth and survival of aquatic life. The sensed data is transferred to the aqua farmer mobile through cloud. As a result preventive measures can be taken in time to minimize the losses and increase the productivity.**

Keywords— pH, Ammonia, Dissolved Oxygen (DO)), Temperature, Nitrates, Salt, Carbonates, Bi-Carbonates, Raspberry-Pi, Sensors, Internet of Things (IoT), Wi-Fi Module.

I. Introduction

Aqua culture is one of the flourishing sectors in India as it contributes nearly 1.07% of the GDP. It is estimated that fish requirement of the country by 2025 would be order of 16 million tones but due to over fishing natural fisheries have been depleted as a result commercial aqua culture came into existence. But in recent years commercial aquaculture is facing many problems due to sudden climatic fluctuation which leads to changes in water quality parameters. At present aqua farmers are depending on manual testing for knowing the parameters of water. This will consume time and inaccurate because water quality parameters may alter with time. In order to overcome this problem, technology should be brought to aqua culture which increases the productivity and minimize the losses by constant monitoring of water quality parameters.

This proposed work uses an integrated on chip computer Raspberry Pi which has an inbuilt Wi-Fi module which makes it unique. It is energized with the help of solar panel which is more reliable and wireless. Several sensors are mounted to sense the data and the data is transferred to the aqua farmer through IOT. Table.1 shows the threshold limits of water Quality parameters for fish culture .If the particular values of water quality crosses the threshold range the aqua farmer will get an alert with feasible solution shown in Table.2.

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 for aquatic life.

S.No	Water Quality Parameters	Range
1	Dissolved Oxygen (DO)	(4-10) ppm
2	Ammonia	(0-0.1) ppm
3	pH	(7.5-8.5) ppm
4	Temperature	21^0C-33^0C
5	Salt	(0-2)ppt
6	Carbonates (CO_3^{2-})	(20-40)ppm
7	Bicarbonates(HCO_3^-)	(150-500)ppm
8	Nitrates(NO_2)	(0-0.3)ppm
9	Sour gas (H_2S)	(0-0.4)ppm

Table.1 water quality parameters with threshold range

Water quality parameter	Below threshold range(following measures should be taken)	Above threshold range(following measures should be taken)
pH	1.Agriculture lime(25kg per acre) 2.pvc lime(25kg per acre)	1.sugar 2.Lemon salt 3.Gypsm 4.probiotics
Salt	Impractical	Pumping fresh water into the tank
Hardness	Impractical	EDTA solution 1kg per acre
Ammonia	Impractical	Fresh water into the pond maintaining high Do, lowering feeding rates
Unionized Ammonia	Impractical	Geolites(20kg per acre),yucca products(300gm per acre)
Nitrate	Impractical	Salt is used
Dissolved Oxygen	Turning on aerators ,oxygen pills	Impractical

Table.2 causes and effects of water quality parameters

II. Literature Survey

Recently IoT is reaching the ground level with its application to farmers [12], [13]. Several papers in literature survey focuses on how the aquatic life will effect due to change in water quality parameters [4] and how IoT technology is used to overcome the problem.Some papers uses Arduino as micro controller for monitoring the aqua field [1],but Raspberry Pi-3 is more advanced when compared to Arduino as it has inbuilt Wi-Fi module[9], [10].Many of the papers concentrates on few type sensors like DO, pH, Turbidity [1], [3], [8] etc and a solution to those problems, but the growth of aquatic life depends on many parameters of water like Ammonia, Nitrate, Carbonates, Bi-Carbonates, salt etc. All these parameters are sensed using multiple sensors and a feasible solution was given to the aqua farmer.The sensed data will be sent directly to the aqua farmer [2], [5], [7]. But storing the data in cloud database helps us for analyzing the data using data analytics which can help us to take pro-active measures before the change in water quality parameters. The overall system is energized with the help of municipal electricity back up with a battery. But aqua farmers are facing power cuts as a result solar energy can be used as a power module which is more reliable and can move anywhere in the pond without the use of wire. Most of the models concentrates on sending the sensor data to the farmer but our model mainly concentrates on providing the solution such as which medicine should be applied or necessary action to be taken in the form of an alert message when the water quality parameters changes.

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III. Proposed Method

The proposed model mainly focuses on constant monitoring of water quality parameters from time to time in order to take preventive measures before actual damage was done. The proposed architecture consists of four modules 1) power module 2) sensor module 3) microcontroller module 4) output module which was shown in Fig.1.

1) Power module:

The power module we opted is more eco-friendly. The power module comprises of solar panel, charge controller, battery, DC-DC converter.

Solar panel is used to extract the heat from the sun and converts into electrical energy and is given to charge controller it is used to charge the battery at constant voltage as a result the life of battery increases. Battery is mainly used to supply power during night because water quality parameters mainly alter during night. A DC-DC converter is used to supply power to microcontroller module which can operate at 5V. A DC-DC converter is used to supply constant voltage.

2) Sensor module:

The sensor module comprises of several sensors such as Dissolved Oxygen, Ammonia, pH, Temperature, Salt, Nitrate and Carbonates .These sensors are mounted on Raspberry pi and are used for sensing the water quality parameters from time to time.

3) Micro controller module:

It is considered as heart of this architecture. Raspberry pi3 is used as computer in this paper .Raspberry pi is a low cost, small computer board with Linux as operating system. It has several advantages when compared to other micro-controllers such as inbuilt Wi-Fi module. The Program for collecting the sensor data is written in python language and sends that data to the cloud database.

The server side program continuously monitors the sensor values whether they are within the threshold range .If the values deviates from the threshold range a feasible solution was send to the output module as shown in Fig.2.

4) Output module:

Aqua farmer mobile is taken as an output module. An app has been loaded in the mobile which consists of two buttons 1) Get data 2) History. When we press getdata button current water quality parameters values has been displayed on the farmers mobile. Message alerts will be sending to the farmer if there is deviation from the threshold range with necessary action to be taken.

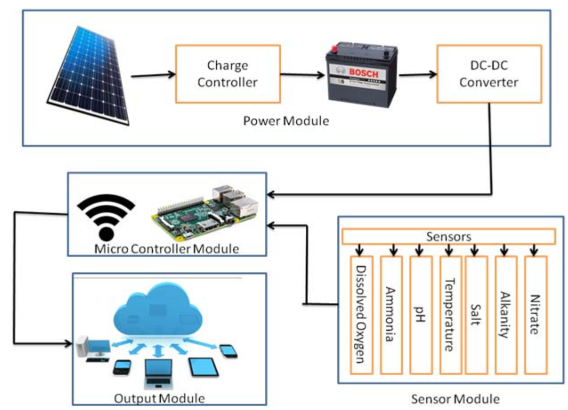

Fig.1 System Architecture

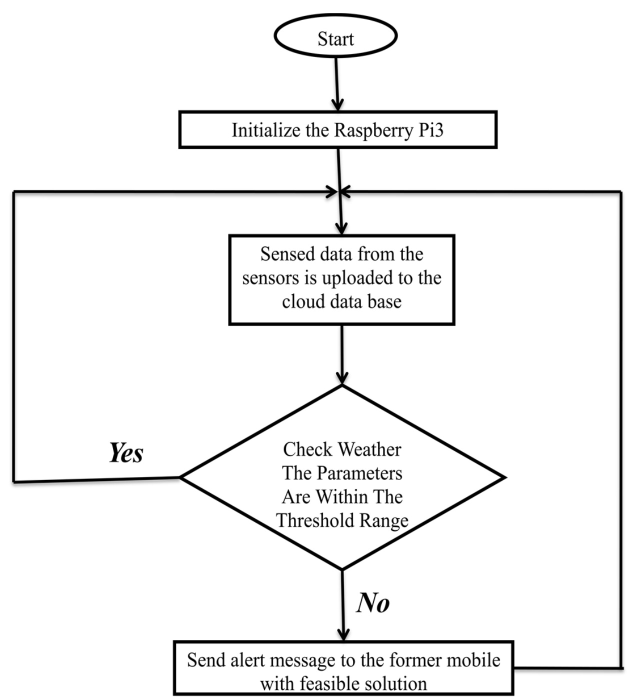

Fig.2 Flow chart for the proposed model

IV. RESULT

The proposed model was implemented in an aqua pond and results were obtained for 24 hours using various sensors. The following are the plots obtained for varying water quality parameters with respect to time.

Fig.3 shows the plot of Ammonia with respect to time the graph shows red colour during the time 10 A.M to 5 P.M during that particular interval of time the ammonia value crosses the threshold limit. During that time the farmer will get an alert message to "to enter fresh water into the pond".

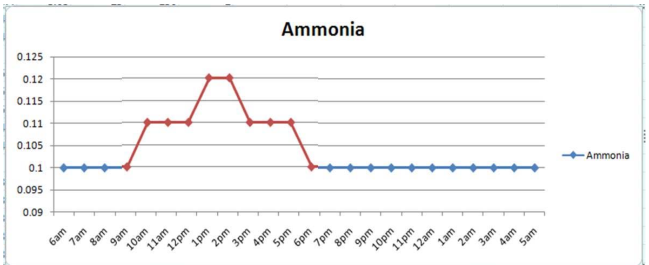

Fig.3 Varation of Ammonia with respect to time

Fig.4 shows the variation of Dissolved Oxygen with respect to time .During 8 P.M to 5 A.M the DO values falls beyond the threshold range.during that particular interval of time they get a alert message to give "oxygen pills or if possible on the aerator set".

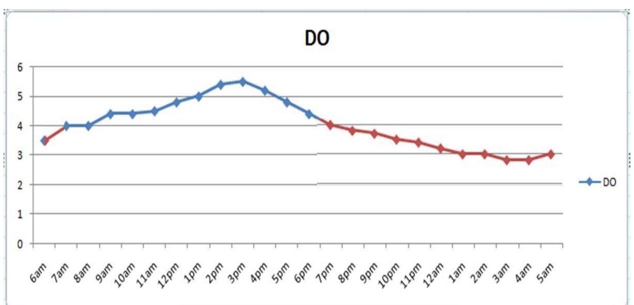

Fig.4 Varation of DO with respect to time

Fig.5 shows the variation of Salt parameter with respect to time.the plot shows that the parameter doesnot crosses the threshold limit.

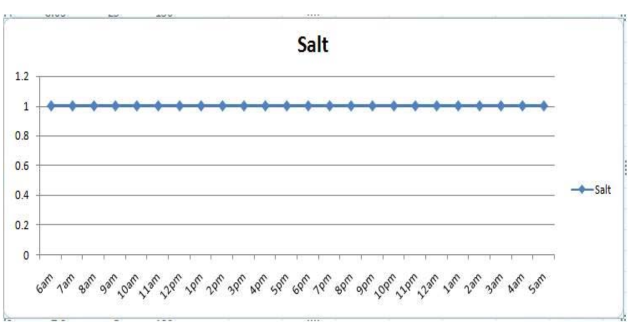

Fig.5 Varation of Salt with respect to time

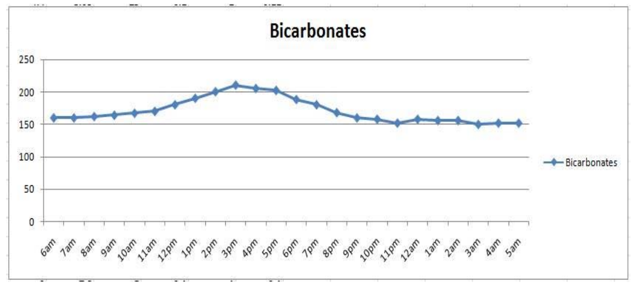

Fig.6 Varation of Bi-Carbonates with respect to time

Fig. 6,7,8 shows the variation of Bi-Carbonates, Carbonates and pH with respect to time. These parametrs doesnt crosses the threshold range during that 24 hours and Fig.9 shows the how the multiple water quality parameters alter with repect to time in a single plot.

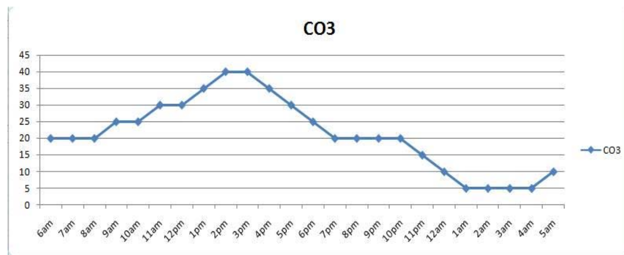

Fig.7 Varation of Carbonates with respect to time

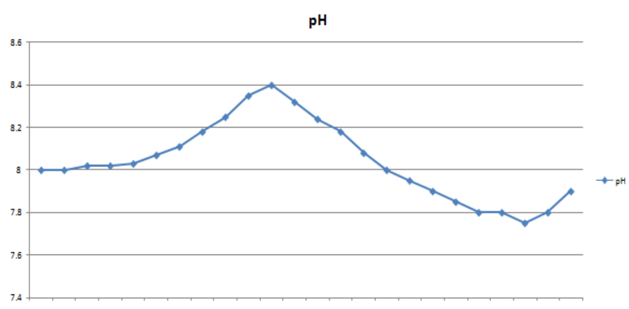

Fig.8 Varation of pH with respect to time

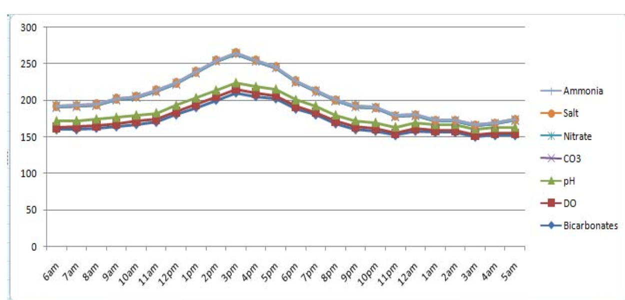

Fig.9 Varation of water quality parameters with respect to time

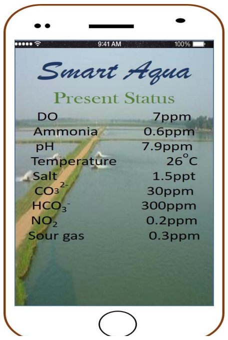

Fig.10 Present status

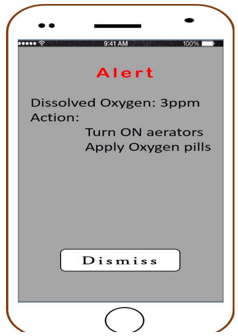

Fig.11 Alert message

Fig. 10 shows the present status of water quality parameters when requested by the user. Fig.11 shows the alert message with feasible solution when the values deviates from the threshold range.

CONCLUSION

This paper help the farmers for accurate and reliable monitoring of water quality parameters because manual testing can consume time and water quality parameters may alter with time being and it helps to take pro-active measures before necessary damage was done. Though the initial cost is high there will be no additional cost and maintenance once it gets installed. Further there is no need for manual testing periodically. It saves time and energy. Thus IOT has reached the farmers for reducing the risk from climatic fluctuations and ensures growth and health for aquatic life. This increase productivity and helps for improving the foreign trade and increases the GDP of the nation. Further the collected data can be analyzed using big data analytics and preventive measures can be taken before the water quality parameter crosses the threshold range. The aqua system can be made automation using internet of things which reduces the energy consumption and labor cost.

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