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An Automated Water Quality Monitor and Fish Feed Dispenser system in Aqua Farms using Internet of Things

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ABSTRACT

In aqua farms, Fish Feeding and water quality Monitoring is an important challenge. Best Feeding practices trigger the growth and health of Fish while Inappropriate practices lead to food contamination in the water and result in high cost. An Automated Feeder system can solve the existing manual feeding problems and the water quality monitoring system can help to analyse the quality and plan the cleaning. Internet of Things (IOT) is a useful technology and finds its applications in many areas. In this work, water quality of aqua farms is monitored with raspberry pi and several sensors along with a camera. Water quality is calculated with the temperature, pH, colour and the measured parameters are sent to the raspberry pi and processed. A fish food dispenser system can be customized and the Manager can monitor the quality using an android application. The Proposed System would support the operations of aqua farms and can efficiently minimize the cost and the environmental impact.

Key words: IOT, Raspberry pi, Fish feed dispenser, turbidity checker, sensors

I.INTRODUCTION

The Demand for Fish and fish products are increasing day by day. According to the UN, the production of fish and fish products is about 128 million tons worldwide. The Human reliance on Fisheries is expanding and the fish intake per individual is about 15%. According to UNFAO the fish consumption will be 17 kg per year in 2030. So, aqua farming is one of the thriving businesses in many countries of the world. Aqua farming relates to the rearing of marine plants and animals. This Industry is a contributing factor for finance and food produce improvement. Commercial aqua farming is facing numerous issues because of changes in water quality and manual labour constraints. Aqua farmers mostly rely on manual labours for feeding the animals and to check the water quality.

There are automatic fish feeders that are electronic devices that can dispense the right amount of food pellet at the right time. They can repeat the task daily without manual intervention and accuracy can also be ensured. This method increases the efficiency and productivity of aqua farms. According to [1], the device fed fish in the exact schedule. The amount of food fed can also be pre- set by the user. This setting

avoided the issue of fish over feeding. Till date, many aqua farmers use the manual feeding system. This increases the cost of manual labour as they are needed to clean the feeder, refill the food and for maintenance of the system. It also increases the time, cost and energy. When compared with automatic feeder systems, the manual feeder system users will find it difficult to manage the feeding schedule.

Water Quality Management of Aqua farms is also a time consuming process because of manual testing. It also gives inappropriate results as there is variation in the water quality continuously. IOT technology can be brought to aqua farming to overcome these problems.

In this work, an integrated and automated Fish feeder system and water Quality monitor with Internet of Things (IOT) technology is proposed. An On chip Raspberry pi with inbuilt wifi module is used in our system for Data processing. Sensors are used to capture the various parameters like temperature and pH of the water. A camera is used to capture the colour quality of the water. For Dispensing food pellets to the fish, a motor is combined with the cycle time to enable dispensing food in all directions. The amount of pellets dispensed can also be controlled by the user using an android application. A speed regulating system determines the travel distance of the food pellet and the area where they land.

II.LITERATURE REVIEW

Internet of things technology is used by agriculturists [3][4]. There are many papers that focus on measuring pH, temperature and turbidity [5][6] but no solutions have been drawn from them. To get the best fish produce, the physical and biological characteristics of water too plays a major role. So, effective aqua farm management is determined by the water quality. Raghu et al[7] used several sensors to measure temperature, salt, pH, nitrates and carbonates in water. But such a use of sensors is costly and not efficient.

Based on the study, there is no need to measure lots of parameters because some parameters can cause an imbalance of other parameters. From the quantity of some parameters, others can be predicted. Temperature affects physical and biological characteristics of water. For every 10 degree increase in temperature, the chemical nature of water doubles. If the water temperature drops to less than 5 degrees, some fish may not thrive. Fish do not have resistance to the sudden change in water. The Temperature is an important parameter and has to be monitored because other parameters like conductivity and salinity depend on it.

The pH is the concentration of hydrogen ions in water and they determine if the water is acidic or alkaline. The pH concentration of water increases during the day and decreases during the night because marine plants emit carbon dioxide during photosynthesis. Before dawn, water has low alkalinity in the range of 6 to 7.5. The pH level of water has to be controlled to reduce ammonia and hydrogen sulphide.

Salinity is another important parameter. Every variety of fish can thrive in a particular salinity only. They can be measured by calculating the concentration of various ions in water. Conductivity of water can be measured with TDS and other dissolved solids.

The turbidity of the water can be determined by the colour of the water. The water may be greenish due to the presence of phytoplankton. The water may be brownish due to clay. Clear water indicates the water is not fertile enough and may cause deficiency in fish development. When fish is grown in muddy water, their gills may be obstructed with clay and can result in death of fish. If the water is dark green, it may be

due to over generation of planktons. Green colour of water should be maintained for fish to thrive as it may be an indication of good plankton population [8].

III.METHODOLOGY

The Methodology comprises the hardware and software requirement for the Fish feeder and the water quality monitor along with the description of the architecture.

3.1 System Design

The main system component of the smart fish feeder and water quality monitor machine is a control system using Raspberry pi. It receives the data from the sensors in the aqua farm and sends the instruction to the motor drive. The block diagram of the fish feeder is given in Fig.2

3.1.1 Hardware and software Requirements

a)Raspberry Pi:

The Processing system of the work is Raspberry Pi3. It is a small and a low cost processor board. This is installed with a Debian version of the Linux operating system. The third version has a higher processing speed than the previous versions. It has an inbuilt bluetooth and wireless module. It can be serially connected with an arduino board.

b) Arduino

Arduino Microcontroller is a processor board based on ATmega32. It is an open source microcontroller board used for programming sensors and actuators. This board is utilized to receive data from the sensors. It has 14 digital input/output pins. Some of the pins can be used as outputs for Pulse width modulation. They can be easily connected with a USB cable to the computer. IT is a low cost board and can be easily upgraded. The Arduino board receives data from sensors and activates the functioning of actuators. Arduino is programmed to send an alert to the user when the sensors detect the limit level in the tank.

(a) (b)

Fig 1: a) Raspberry Pi b) Arduino c) Sensors

Analog pH sensor (SEN0161) is used to measure pH of the water in the aquaform. This sensor is used with arduino and has built in connections. The range of this sensor is 0 to 14 pH and has an accuracy of ±0.1 pH. The standard operating Temperature is 25 degrees. Some part of the sensor is inserted into water. The sensor can last for about half a year if the water is clean. When the water is turbid, the sensors need to be replaced monthly. Electrical Conductivity meter is used to measure the conductivity. Temperature sensor(DS18B20) is used to measure the temperature of water. The sensor is waterproof.

c) Ultrasonic Level Sensor

The Fish food level in the tank is monitored by an ultrasonic level sensor. The transmitter and receiver is installed on the top of the tank. The Ultrasonic sensor measures the distance from the transmitter to the aqua tank surface by calculating the time taken for the sound wave to be reflected by the object and the echo signal. Ultrasound is normally used for finding the location of the fish in the sea and also submarines

d) User Interface

The User Interface is installed in the system that is used to set controls. The Manager can use the smart phone by installing the APP to receive alarm notification to change the feeding schedule and amount of feed.

e)Alarm system

The Alarm system is a buzzer that is used to send alerts to the manager when the food level reaches the limit and alerts the manager to refill. The buzzer is also used to alert the manager when the water quality is not good. The Buzzer used is a piezo electric buzzer with a piezoelectric material and vibrates to generate sound.

f) Servo Motor driver

The servo motor receives the voltage input from the arduino controller and sends output voltage and current to the servo motor to rotate the Fish feeder system. It also controls the torque,velocity and position of the motor.

g) Servo Motor

This Servo motor is used for dispersing Fish Food. The Motor provides a good torque range. They can run at high and low speeds accurately and can be precisely controlled.

h) Power Supply

It provides electrical energy to operate the devices. The power supply used in the project converts Alternating current (AC) to direct current and supplies power to devices connected in the feeder system.

Figure 2 shows the block diagram of the system. The Fish food bin activator activates the food pellet distribution system using a timer control. The input from the user is forwarded to the control system which generated the bin activator to release or close the bin. The User can set the Food timing schedule when the aqua farm has no manual labour. The amount and frequency of feeding for the fish is converted into programs and the programs can be altered depending on the arrangement. Proper amount of food and

its frequency is ensured by a timer which dispenses food through pipelines connected to the servo motor. The Servo motor rotates in all directions to dispense food and ensures equal share of all fish in the farm. When the Food pellet in the bin reaches the lower limit, a buzzer sounds and the alarm signal is also notified to the user. After all the food pellets are distributed, the pipes are flushed with water to maintain the pipe clean. After notification the manager of the farm can refill the food bin.

The Temperature and pH sensors are connected with arduino and the arduino is connected with raspberry pi. The Data from the sensors is collected with the arduino board. The raspberry pi is connected to the arduino with the USB cable connected serially. The program in raspberry pi is written with python and the database used is mysql. A camera is connected to the raspberry pi to take the images of the water. From the image captured, CNN algorithm is used to find the turbidity of the water.

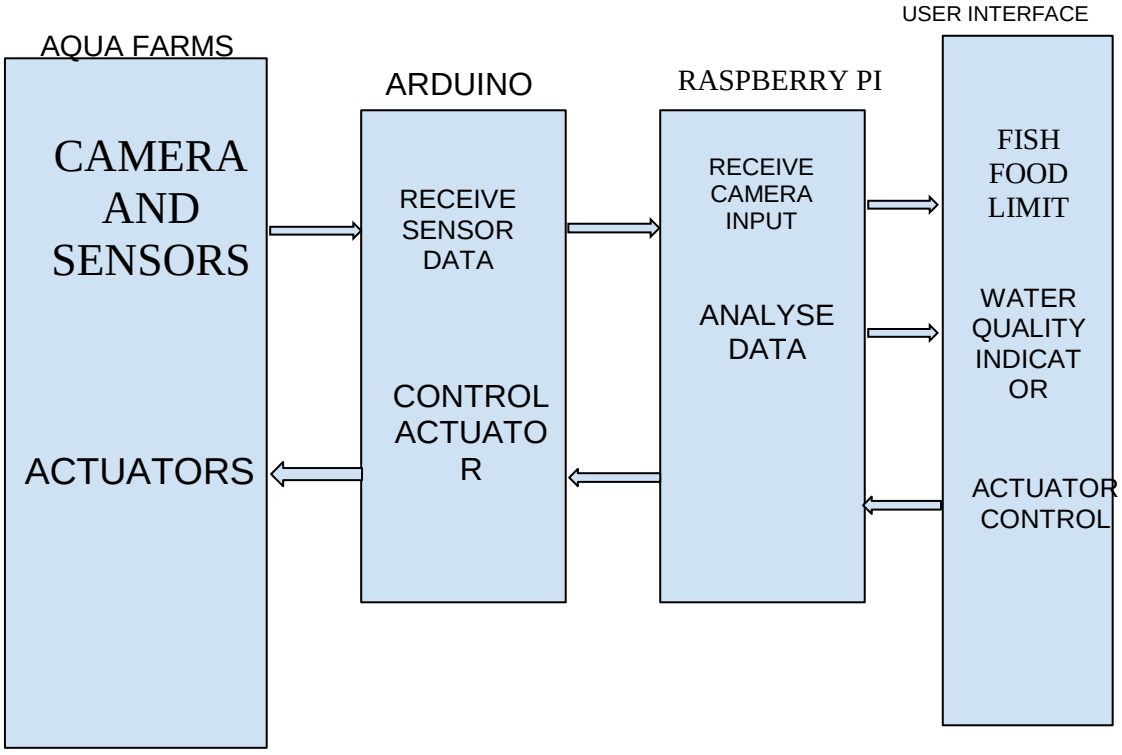

Fig 2: Block Diagram

IV. IMPLEMENTATION AND RESULT

A Prototype of the fish feeder system is constructed with a food bin and servo meter. By enabling the timer and the user input, the fish feeder system dispensed food pellets in all directions and also ensured that an alarm is triggered when the food in the bin reaches the lower limit. The user was able to control the device using the smart phone app. After the scheduled time, the system also flushed the pipe from where the food was dispersed to clean it.

TIME	TEMPERATURE	pH
07:00	21.4	8.2
08:00	22.9	8.3
09:00	23.4	8.5
10:00	24.3	8.5
11:00	24.7	8.3
12:00	25.4	8.7
13:00	25.6	8.5
14:00	25.3	8.7
15:00	24.3	8.7
16:00	23.2	9.0
17:00	23.1	9.1
18:00	23.0	9.2

Fig 3 : Implementation of Water Quality Parameters

Water from an aqua farm was selected as a standard colour with the help of an aquaculture expert. The image of the pond water was captured with the help of a camera. The RGB values of the camera were calculated from the image. A range for all the colours was set up. For red colour the ranges were 90-100, for blue 50-60 and for Green the ranges were from 90 to 120. Based on these values, the turbidity level was monitored and notified to the user. The proposed system was implemented in the pond water for a day and the temperature and pH level was taken on an hourly basis and notified to the user. Figure 3 and 4 represents the implementation in tabular and graphical form respectively.

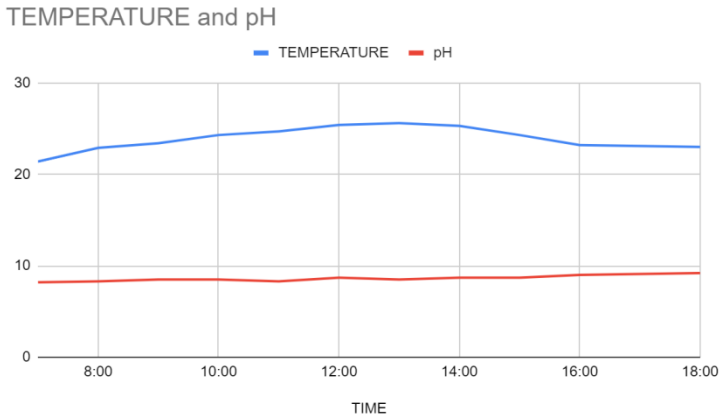

Fig 4: Graphical representation

V. CONCLUSION AND FUTURE WORK

This work implements an automatic Fish feeder and water quality monitoring system with Internet of things. It gives better results with low cost and reduces dependency on manual labour. This will help the aqua farmers to produce fish with better quality and reduce the operational cost. The water quality monitoring system automatically keeps a check on the quality of water and notifies the user of any dangerous signs and can be rectified immediately. Deep networks can be used to accurately measure the

quality of water and prediction algorithms can be applied to predict any future problems that may incur. More actuators can be connected to automate many processes related to aqua farming.

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