International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 05 Issue: 07 | July -2021 ISSN: 2582-3930

Smart Aquafarm Monitoring System

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Abstract – Looking at current environmental condition and Global climate change, it is getting worst day by day and it is affecting all the life cycles in the surroundings. As far as marine fishing is concern we can't get sustainable fish quality due to pollution and other environment affecting aspects so it may leads to growth of aquaculture farming. Looking at traditional aquaculture farming it is quiet tough, long and hectic process to monitor all the aspects of farm. As production is more dependent on water quality parameters so this project discusses the monitoring the water quality parameters using different types os sensor and collecting data collectively and send it to cloud so than it can be accessible from outside the farm with less error and much easily. This project also discusses the use of automatic feeding system to reduce the excess food passes during traditional feeding which affects the quality parameters which should be avoided using this. Lastly this project discusses on tracking of fish and monitoring growth rate using artificial intelligence in which we can track the fish using camera and seen it on our screen. This project help us to make smart aquafarm system using current ongoing technologies.

***Key Words*:** Global Climate Change, water parameters,, sustainable fish quality, artifial intelligence

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1.INTRODUCTION

Due to increase in population the demand of protein rich fish increasing day by day but looking at current environmental condition it is not possible to fulfil everyones need as production decreses along with the quality of fishes so this project is focusing on enhancement of shrimp farm management through the embedding of multiple wireless communication technologies. The technologies of RFID, WSN, mobile application platform and IoT systems will be embedded into one platform as an efficient solution for aquaculture quality monitoring (AQM) and it gives error free data which can be handled from anywhere. This Project also involves some artificial intelligence techniques to track the fish and monitor the growth of fish without harming the fish and AI provides complete control over the fish producing systems with less maintenance and reduced input cost and it monitors the tank easil

Looking at population demand of fishes increases day by day and it is required to fulfil the Demands coming in the way which is possible only if the production is increases without any risk but is is quite difficult with traditional model as it is very long and slow process so to decrease the risk of production, to increase the farm sustainability we need to use this model so we can get accurate water quality parameters so that it will be easy to maintain the proper habitual environment. Looking at the workers safety it require to use some advance technologies which reduce the harm to workers working there. As per as measuring water quality parameter manually it is quite lengthy process and sometimes full of error so we need error free data so this project help us to overcome that problem.

There are some advantages of this project in real time which are mentioned here. Starting from sensors we will get accurate measurement of water quality parameters and that too with reduced error. Following to this we can able to access it from anywhere as we have use cloud technology. Due to automatic fish feeding system we will able to provide nutritional food in fixed time interval . In real time we can easily track the growth of fish just by detecting moment of fish and size of fish by computer vision.

As far as project structure is concern, project is divided in the 3 parts. In first part of structure we will able to check water quality parameters with the help of different types of sensors and which we can placed according to the pond size and structure. In second part of structure we need to create automatic feeding system according to plant size and number of fishes in it and while installing it in real time we need to adjust the time as per the nutrition requirement of fish. In 3rd part of the structure we just need to install cameras according to there focus and the part which we want to track and we can just track the movement of the fish and growth rate just by seeting in the control room and some cameras we can use to check the position of sensors.

2. SYSTEM OVERVIEW

As we have mentioned in complete flowgraph we started working on the project as we are doing extension to previous project we need to study the overall working and what are the problems arises while system is in working mode so we came across some things which we can implement in our project as automatic fish feeding system and Fish detection and fish growth tracking.

Here we use Atlas scientific pH sensor of range 0 – 14 moles to measure the acidity & alkalinity of water. If the pH value of water is between 6.5 – 8 then it is considered as neutral. If pH value of water goes above or below the certain value i.e. 6.5 – 8 , then filter motor will turns ON & maintain the pH of water. But sometimes filter motor is not enough to maintain the pH .In this situation we use lime solution to maintain the pH. After that we use Temperature sensor which is generally a thermocouple to measure the temperature inside the tank . If temperature of water is between 59-77F (15-25 C) then it is considered as a neutral. If temperature of water inside the tank increases then cold water is added into water to normalize the water temperature & if temperature decreases then heater will ON automatically & maintain the water temperature. After that we use Ultrasonic sensor to maintain the water level inside the tank. If water level exceeds the set level then the extra water will goes out from outlet pipe & if water level reduces then extra water will added through inlet pipe. In this system we use a TDS meter to measure the dissolved solids in water. If TDS will above 5ppm it is ok. If

TDS goes below 5ppm then we use either Phosban or AMQUEL solution to maintain the TDS. Here we use AMQUEL solution. After that ,to maintain the oxygen level of water we use air pump. Air pump should be placed horizontally at the bottom of tank for better result. The data collected from respective sensors are go for processing & controlling to Raspberry pi. Here we use Raspberry pi 3B+ as a control unit. All the data are processed & displayed on the LCD display for monitoring.

After doing review of existing system we started working on automatic fish feeding system. As looking at the current situation it is not possible to visit aquafarm to get the information regarding fish nutrition we searched on google and decided to make one prototype of automatic fish feeding system. Due to availability of some components we have started to build feeding system for this we have use Arduino Nano and Servo motor.Initially the shaft of servo motor at 45 degree.We want to feed the fish twice a day hence we define two conditions & set the time in the form of Hours ,Minutes & seconds. When the time matches with settled time, the shaft of servo motor will rotates to0 degree from 45 degree & back to 45 degree after 5 seconds. You can adjust the delay time as per how much food you want to feed the fish. After this We attached this prototype model to fishtank available with us. This completes the work on automatic fish feeding system.

Going forward as per flowgraph we started working on fish detetction and tracking. But as artificial intelligence is new topic for us we started collecting information. After getting sufficient information we decided the workflow for fish detetection to fish size measurement as mentioned below :

Step 1 : Object Detection :

Before going towards fish detection it is require to apply detection model on normal object. For that we have first initialize the camera from which we can start capturing the frames. In this procedure we require to give a reference image background frame which will further use by the system to compare. As we bring one object in front of camera it will be detected as it gets compare with the pixels of reference image and due to the change in pixels we get notification as movement or moving object detected.

Step 2 : Fish Detection :

After Object Detection, We have try this model on fish tank available with us. Like object detection we gave a reference background which is fix as we are getting some difficulty to bring stable image as water is moving. After getting stable background we bring fish in front of camera it start detecting the fish by rectangle around that fish using this technique we can track the movement of fish to check whether have some health issue or not.

Step 3 : Fish Size Measurement :

As far as previous project is concern they don't have a system to check the growth of fish so we have decided to add the system which gives idea about fish growth. After lot of search we found one technique with help of which we can get approximate value of fish. So We decided to measure the size of rectangle. For this technique we require to give a reference object with size mentioned so that by comparing it will give actual size of rectangle.

Step 4 : Fish Growth Rate Analysis :

To check reliability of project we have collected data of some days i.e size of rectangle and plot the graph to check the size and got the result positive as growth of fish in AQM condition is quite faster than normal.

Step 5 : Fish Recognition :

Sometimes it is quite difficult to segregate fishes just by looking at it and becomes long and time consuming process so we have decided to make prototype model as we are getting error in main model. For this prototype model we have use tensorflow lite model as pretrained model alongwith mobilenet ssd model with over 1000m datasets and applied it on system. We get an notification as name of fish which we will use to recognise and segregate different types of crabs,lobsters etc.

So finally to monitor all these things from single screen we have made one collective controlling window with various tabs in it. This all about work regarding the project and we will see output of the system in result section.

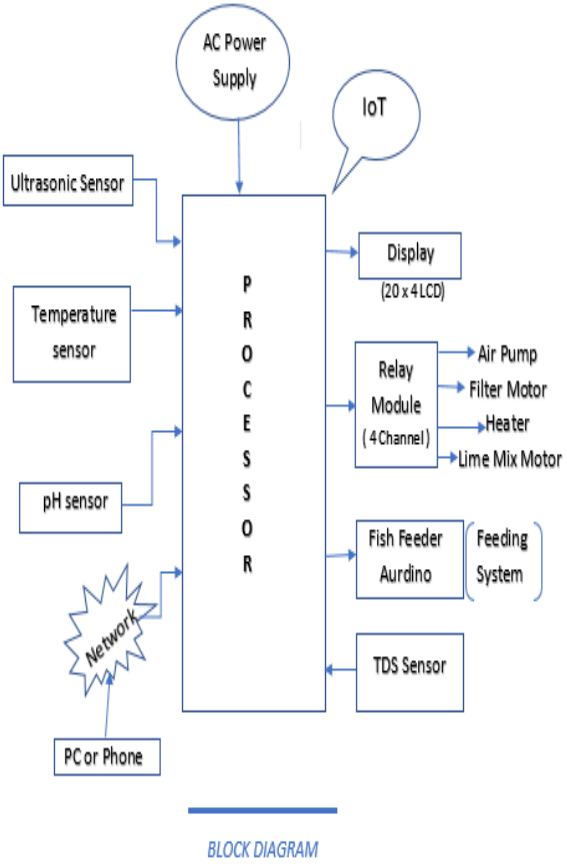

Fig-1: Block Diagram of Aquatic Farm Monitoring System

2.1 SYSTEM REQUIREMENTS

2.1.1 Raspberry Pi 3B+

The Raspberry Pi 3B+ is a credit-card sized computer that plugs into your TV and a keyboard. It is a capable little computer which can be used in electronics projects, and for many of the things that your desktop PC does, like spreadsheets, word-processing and games.

1. Speed: 1.4 GHz 64-bit Quad-Core Processor.
2. 1 GB RAM Dual Band 2.4GHz and 5GHz
3. IEEE 802.11.b/g/n/ac Wireless LAN
4. Enhanced Ethernet Performance
5. Voltage:5v-2.5 amp

2.1.2 PH sensor

A pH meter is a scientific instrument that measures the hydrogen-ion activity in water-based solution, indicating its acidity or basicity expressed as pH. A pH sensor is one of the most essential tool that is typically used for water measurement. This type of sensor is able to measure the amount of alkalinity and acidity in water and other solution. When a substance has a pH value of seven, this is considered to be neutral.

1. Measuring Range 0 to 14.00 pH
2. Module Power :DC 9.00V, 1A
3. Accuracy 0.1 pH,
4. Response Time:<=1min
5. Output:0.5 to 3V
6. Internal Resistance:250M0
7. Operating Temperature:0 to 60^0 C

2.1.3 Air pump

An Air pump is one key way to add oxygen to the water, allowing fish to breathing easily and grow healthy. Air pumps for lakes, ponds and tanks are typically connected to an aeration device.

1. Voltage: 220-240V
2. Frequency: 50/60Hz
3. Watt: 2.5W Max
4. Output: 3L/Min.
5. High technology
6. Excellent and reliable quality
7. High output, Safe and quiet operation

2.1.4 Heater

Heater is Electrical device, which is used to heat the water. When water Temperature below the threshold limit then Heater is ON through Relay module. Switching of Heater accordingly requirement by using Raspberry Pi.

1. Temperature range: 20°~34°C
2. Power: 100W
3. high quality quartz glass
4. double seal material

2.1.5 MCP 3204

The Microchip Technology Inc. MCP3204/3208 devices are successive approximation 12-bit Analog-to-Digital (A/D) converters with on-board sample and hold circuitry. The MCP3204 is programmable to provide two pseudo-differential input pairs or four single-ended inputs.

1. 12-bit resolution
2. Four single-ended inputs
3. SPI interface
4. 100 sampling rate
5. -40 to +85°C temperature range

2.1.6 20x4 LCD Display

20x4 means that 20 characters can be displayed in each of the 4 rows of the 20x4 LCD, thus a total of 80 characters can be displayed at any instance of time. These signals are recognized by the LCD module from status of the RS pin. Now data can be read also from the LCD display, by pulling the R/W pin high

1. Type: Character
2. Display format: 20 x 4 characters
3. Built-in controller: ST 7066 (or equivalent)
4. Duty cycle: 1/16
5. 5 x 8 dots includes cursor
6. + 5 V power supply (also available for + 3 V)
7. LED can be driven by pin 1, pin 2, pin 15, pin 16 or A and K

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2.1.7 Four channel relay module

The four channel relay module is a convenient board which is used to control high voltage, high current load such as motor, Heater, Air pump. It is interface with microprocessor such as Raspberry pi 3B+. It also comes with a led to indicate the status of relay.

1. relay module is 5V active low
2. output maximum contact is AC250V 10A and DC30V 10A.
3. Working status indicator lights

2.1.8 Raspbian Arduino Nano

Raspberry pi OS (formerly raspbian) is a De bian based operating system for raspberry pi. Since 2015 it has been officially provided by the raspberry pi foundation as the primary operating system for the family of raspberry pi single-board computers. The original raspbian OS was created by Mic Thompson and Peter Green as an independent project. The initial build was completed in June 2012. Previous pi OS has been 32 bit and based on raspbian core, taking the name rasp bian. Since recent 64 bit versions no longer use the raspbian core, the name has been change to raspberry pi OS for both 64 bit and 32 bit versions raspberry pi OS is highly optimized for the raspberry pi lines low performance ARM CPUs.

2.1.9 Arduino Nano

The Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328 (Arduino Nano 3 x). It has more or less the same functionality of the Arduino Duemilanoye but in a different package. It lacks only a DC power jack, and works with Mini-B USB cable instead of a standard one.

Specifications :

1. Microcontroller – Atmega328
2. SRAM – 2 KB
3. Architecture – AVR
4. DC Current per I/O pins – 40 mA (I/O pins)
5. Flash Memory - 32 KB of which 2 KB used by bootloader

2.1.10 Webcam / Camera

A webcam/camera is a video camera that feeds or streams an image or video in real time to or through a computer network, such as the Internet. Webcams are typically small cameras. Webcam software enables users to record a video or stream the video on the Internet. As video streaming over the Internet requires much bandwidth, such streams usually use compressed formats. The maximum resolution of a webcam is also lower than most handheld video cameras, as higher resolutions would be reduced during transmission.

2.1.11 Servo Motor

A servo motor is a type of motor that can rotate with great precision. Normally this type of motor consists of a control circuit that provides feedback on the current position of the motor shaft, this feedback allows the servo motors to rotate with great precision. If you want to rotate an object at some

specific angles or distance, then you use a servo motor.
It consists of three parts:

1. Controlled device
2. Output sensor
3 Feedback system

2.2 METHODOLOGY

The methodology is illustrated by considering a small aquafarm system in small fish tank. The implementation of automatic feeding system is done by using small prototype model which placed above small fishtank. By using webcamera outside the tank we have implemented the detection and tracking model. As it is not possible for us to work collectively so we did it separately and then implemented on a fishtank.

2.3 SYSTEM DEVELOPED

The prototype model of system as shown in Fig-9 and Fig-10. This system is developed at small scale level by using fish tank. The side view and front view of system as shown in figure. In this system also include filtration system at small scale level. Statuses of system are indicated by using LCD display. This (Figure 3.10) is the design detail of Fish detection. Fish Detection will be done by frame to frame comparison which highlighted by labels and by training we will come across is there any moment or not which will be highlighted using rectangle around detected object. In this technique model is pretrained for feature extraction. Using Feature extraction it detects the object as trained into datasets and labelled. As it detect cat we will be notified using cat as a label this is all about the design detatil of the object detection.

As per as feeding system is concern the following figure (figure 3.11) gives perfect design detail for connecting all the components neatly. In which we have connected servo motor to Arduino nano and using programing we have given the delay so that motor start working and from the pipe which is join to it it feeds the fishes for that given time. We have also add one switch to turn ON and OFF the complete system.

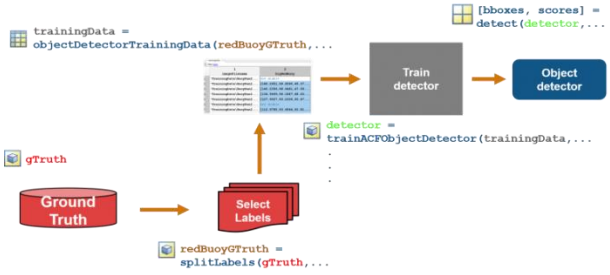

Figure 2 Design detail of Fish Detection

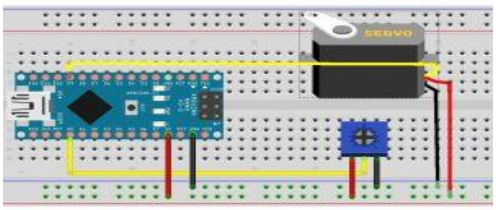

Figure 3 Design detail of Fish Feeding System

2.4 RESULT

As per as Traditional method is concern it is quite difficult to track the growth of fish so we have implemented detection of fish which help us to track the growth of fish. Figure 4.3 shows the detection of fish which is in normal condition and figure 4.4 shows the detection of fish which is in monitored condition. After detection we have been notified by the status about the fish that is is alive or not? And it is useful to track the movement of that fish.

Figure 4 Fish in Normal condition

Figure 5 Fish in Monitored condition

Fish Measurement

After detection it is required to measure the size of fish so that we can conclude the effectiveness of the project which done by measuring the rectangle size as shown in above images. So in conclusion to this we can see the size of fish from figure 4.6 (Monitored Condition) apperars larger than a figure 4.5 (Normal Condition). By this technique we can easily track the growth of fish safely.

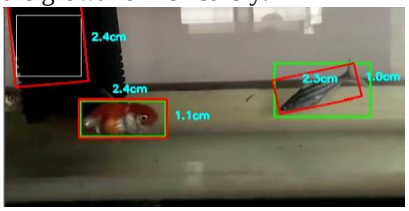

Figure 6 Size of Fish in Normal condition

Figure 7 Size of Fish in Monitored condition

3 CONCLUSIONS

The project carried out by us made an impressing task in the field of Aquatic Farm industries. It is very useful for monitoring fishes as well as water parameters. “Smart Aquafarm Monitoring System” is taking care of our Aquafarm better than a human in both automatic mode and manual mode. Smart Aquafarm System is particular design for increase in fish health purpose and for encouraging the farmer to come in this type of farming. It is to operate and eco-friendly for the environment. The system worked as planned and designed, the

system didn't malfunction and completed all task as assigned by user. In future the system will be fitted with computer vision and have access to monitor fishes and check growth of fishes. The project carried out by us made an impressing task in the field of Aquaculture farm industries. It is very useful for monitoring fishes in tanks and farm models. This project has also reduced the cost involved in the concern. Project has been designed to perform the entire requirement task, which has also been provided.

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