Arduino based Fish Monitoring System

Dr.A.Albert Raj, Dr.Selvan, Swasthik V K, Rakesh A, Saravanaraj D M.

Abstract—Fish monitoring system is essential because many people love to grow fishes as their pet in the home. In our day-to-day life, it is difficult to monitor the aquarium tank regularly. As a consequence, it causes mortality of the fishes. The quality of water might be the main issue. It mainly depends upon parameters such as carbonates, ammonia, nitrates, salt, pH, temperature, turbidity, dissolved oxygen, etc. To maintain these parameters, various sensors are used in the fish monitoring system. This will increase the production of fishes and decrease mortality. Many researchers had proposed various methods for maintaining the water quality in the aquarium and the fish ponds. The main purpose of this paper is to review the sensors used in the fish monitoring system and the critical comparison of various sensors with other research papers.

Index Terms: Arduino, Fish, Internet of Things, Arduino UNO, sensors, Fish feeder.

I.INTRODUCTION

The advances in monitoring, automation technology and aquaculture research have led to the development of production technologies that have improved the quality of fish ponds and fish production. Quality of water greatly influences the growth of aqua cultural objects which affects the production of fishes. Fishes are the main engine that restores the water bodies. Fish integrates the functioning of lower organic process levels and are sensitive to physical system attributes (e.g., hydrologic connectivity). The fish area is ecologically and culturally important for sound recovery, as well as for the cultural heritage of its inhabitants. And overall, fish survival depends mainly on the environment in which they live. Imbalances in the atmosphere must be monitored to allow them to survive Fish from lakes and ponds can die due to several reasons, which may include

- Natural predation, Old age or natural injuries
- Starvation, Suffocation
- Pollution, Diseases or parasites

Continued automatic monitoring of water parameters in real-time will not only result in high-quality aquaculture management, but will also provide accurate experimental data that will help optimize the farming process, reduce farming costs and improve farming efficiency. The fish is susceptible to disease and other problems due to poor water quality in ponds, and daily monitoring of pond water is a panacea for many pond problems. For proper water monitoring, adequate equipment and labor must be available with extensive experience in the problems involved in obtaining accurate information to obtain complete and accurate results The purpose of this article is to design and implement a low-cost system to monitor the process of supplying fish and water quality in aquaculture tanks. The system consists of sensors that measure various water quality parameters (such as temperature, pH, Water level, turbidity, or conductivity, among others), of the tank conditions (such as illumination and water level), and of the fish feeding behavior.

2. PROBLEM DEFINITION

Overfeeding is the main mistake made by fish owners because unused foods will contaminate water. In this project, we use a servomotor and a screw to easily implement intelligent feeding that allows the fish owner to enjoy manual feeding remotely while the fish are not being underfed nor overfed. Issues on water quality in fish farming systems vary widely. An optimal balance of nutrients and other factors like temperature, hardness, pH and turbidity is required to maintain the heath of fish. Temperature affects water quality, and the metabolism of fish changes as the temperature raises PH also affects fish growth. Lower pH levels can accelerate the metals release from rocks and sediments, which can affect fish metabolism and their ability to absorb water through the gills. Dissolved oxygen is one of the important parameters in fish farming. Low levels of dissolved oxygen have a negative impact on the respiration and metabolic activity of fish, causing a high number of fatalities. In our system, we focused primarily on those parameters on which fish health depends.

- *Dr.Albert raj is currently working in Sri Krishna College of Engineering and Technology as Dean Academics. E-mail: albert@skcet.ac.in*
- *Dr.Selvan is the head of Mectronics in Sri Krishna College of Engineering and Technology E-mail: selvan@skcet.ac.in*
- *Swasthik V ,Rakesh A, Saravanaraj D M is currently perusing his third year in Mactronics at Sri Krishna College of Engineering Email: 16eumt101@skcet.ac.in, 16eumt077@ skcet.ac.in, 17eumt518@ skcet.ac.in*

3. EXISTING TECHNOLOGIES

We investigated many related technologies that are involved in the fish monitoring system.

Yi-Bing Lin et al [1] developed an IoT based Mini aquarium system called Fishtalk which used several sensors and actuators. The sensors used were to find the temperature, pH, Electrical Conductivity, Dissolved Oxygen, and total dissolved solvents. However, the Fishtalk system did not have an ammonium sensing sensor and a turbidity sensor which is a measure of the extent to which water loses transparency due to the presence of suspended particles

A Cost-Efficient Automated Pisciculture Assistance System Using the Internet of Things(IoT) is delevoped in[2] which used sensors such as temperature, pH, turbidity and to measure the water damage. Here the author designed this system as a cost-efficient one, he did not have any sensor to measure Ammonia which is also dangerous for fishes if it crosses the lower limit. This system also does not have a system to automate the feeding process.

A distributed IoT system for the monitoring of water quality in aquaculture using three basic sensors such as pH, temperature and dissolved oxygen [3]. This system failed to have sensors to measure Ammonia and turbidity which are also important for the life span of fishes. Guandong Gao et al[4] developed an intelligent IoT-based control and traceability system to forecast and maintain water quality in freshwater fish farms.

The sensors the author used were to measure water temperature, water electrical conductivity, water level, pH value, water body turbidity, and dissolved oxygen. However, this system did not have any sensor to measure Ammonia.

A water monitoring IoT system for fish farming ponds by using basic sensors such as temperature and water level sensors is analyzed in[5]. The author did not include other basic measuring parameters such as pH and dissolved oxygen.

A GSM-based fish monitoring system using IoT is developed in [6]. The sensors used were a temperature sensor, pH sensor, and water level sensor. This system does not have a sensor to measure another important parameter such as Dissolved oxygen. Sensors to measure Turbidity, Electrical conductivity and Total dissolved solvents are also not available.

GSM-based fish monitoring system [7] using IOT explains about the fish monitoring and uses various sensors for monitoring the fish aquarium tank. The sensors like pH, Water level sensors are used to sense the pH level and level of the water. It will indicate the signal through buzzer and LED. The control of this system is done by the Arduino board.

An Intelligent Fish Tank Control System Based on Internet of Things Cloud Computing Platform is designed in[8]. The author used only water level sensors (Water Sensor), light sensor, temperature sensor (DS18B20) and focused much on the Internet of Things Cloud Computing Platform and hence he did not use other sensors such as turbidity, dissolved oxygen, etc.

In[9] the author focused much on the feeding process the sensors used are water level sensors and illumination sensors. Sensors to measure temperature and dissolved oxygen are also used in this system.

Real-time monitoring of water quality in the IoT environment is developed in [10]. The system has several sensors to measure physical and chemical parameters of the water that makes the total system cost effective.

Smart monitoring and controlled aquaponic system-based on IoT is developed in [11]. Core Sensors used in this system are the Humidity sensor and Temperature sensor. Humidity is a measure of the amount of water vapor contained in the air and the value of the sensor can be accessed through smart phone applications and websites from anywhere with the Internet connection.

In the Intelligent Fish Tank Control System Based on the Internet of Things Cloud Computing Platform [12] a cloud-based platform for the Internet of Things (IoT) family intelligent fish tank control system using the sensors are defined.

The sensor used in the system is water level sensors. It senses the level of the water and using the pump the water in the tank increases automatically by using Arduino Mega 2560.

A. Zaini et al [13] developed the IOT based Monitoring and managing Nutrient Film Technique (NFT) Aquaponic and it records water pH, , ammonia gas level, water temperature and water depth through the pH sensor, temperature sensors, ammonia gas sensors, and ultrasonic sensors. Depth sensors can be implemented to retrieve the water depth level on the Aquaponic pond and the ammonia gas sensor implemented to extract the ammonia gas content in the aquaponic pond by adding and compensating value base on the differs of the error value.

T. Abinaya et al [14] proposed a multiple sensors used to continuously monitor the parameters such as pH level, temperature, foul smell detector, Ammonia

content, dissolved oxygen, and water level. In the system, MQ4 ELECTRONIC NOSE is used as a foul smell detector sensor.

In[15] PH value, and water level sensing modules are incorporated in this monitoring system. The temperature sensing module uses the PT100 sensor. The authors used various controllers and transmitting devices to transmit the data sensed by the sensor for further processing. A study to create access and control of pH level and temperature through the Internet of Things (IoT) in Automated Aquaponic system using PH sensor and Temperature sensor is given[16]. Unlike other article this system implemented an ultrasonic sensor to know when to activate the pump for water refilling.

4. RESEARCH METHODOLOGY

The current system includes the Arduino UNO board which is one of the many small board computers, that consumes very low power and it is widely available.

Connected to this control unit are various sensors for monitoring some of the parameters which can be labeled as input units, actuators such as fan that can be labeled as output units, executive units that affect some parameters, such as the heater and some interactive elements such as buzzer.

The IoT smart monitoring system includes several sensors to sense the environment and based on the readings from these sensors, the user can make important decisions for improving the quality and quantity of the fish.

Temperature is the deciding factor for each process shown in the aquarium. This not only affects the development and growth of other plants and animals in the tank, but also regulates the oxygen content in the water. The ideal temperature for tropical fish is 25 ° C and allows deviations at 2 ° C and for fish. The regulation or heating of the water can be done by an external Relay, which receives the control signal from the board and then turns on or off the heater. Also in this parameter there is a fan. The fan is used for cooling down the water if it is beyond the normal temperature. Fan when it is switched on keeping above the water level, it causes the upper surface of the water to evaporate and hence it cools down. The turbidity sensor contains a light transmitter and receiver. At clear waters, light scattering is minimum and so the light receiver receives the most amount of light. As turbidity of the water increases, the light receiver receives less and less light. The sensor triggers when the light received is below a certain threshold.

The IoT monitoring and control system measures the water level in the pond using a simple ultrasonic sensor, which notifies the end-user when the water drops below our desired limit.

This system at this stage communicates to the end-user through the Thing speak and hence provide the person correct data to act upon. The buzzer, which sends sound, signals whenever some of the measured parameters goes out of the desired range locally.

5. PROPOSED SOLUTIONS

5.1.Arduino

The microcontroller based Arduino Uno(ATmega328P) is based on the datasheet. It has 14 digital i/p and o/p pins , a 16 MHz crystal, 6 analog inputs, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.. You can tinker with your UNO without worrying too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again.

"Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board (figure 2) and version 1.0 of Arduino software (IDE) were the reference versions of Arduino, now evolved to newer

Fig 1 Uno board

releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform; for an extensive list of current, past or outdated boards see the Arduino index of boards .

5.2 Node MCU

This system has NodeMCU which is located in the middle of the system built on the ESP8266-12E Wi-Fi module. It is a free and highly integrated system that can be configured to connect to IoT devices, solutions have been implemented in three phases, 1)interaction with arduino,

2)fish design and 3) connection to a perpetual recovery server.

5.3. Interfacing with Arduino

At first, we interfaced sensors such as temperature, pH, ultrasonic and turbidity with the Arduino UNO board as in the figure 2. We found the results for the same in the serial monitor.

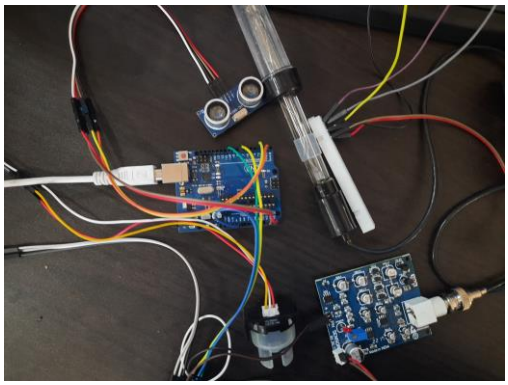

Figure 2 Arduino UNO boardand interfacing with sensors

5.4. Fish Feeder part

Secondly, we designed a 3D model(figure 3)for the fish feeder and successfully printed it using a 3D printer. This feeder uses a servo motor to drop the fish food in the water.

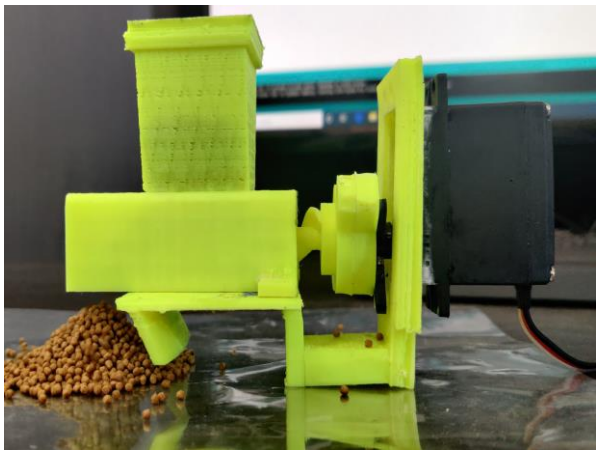

Figure 3 printed 3 D model

5.5. User Interface

Since fish monitoring should be done on a remote basis, We implemented interfacing the sensors with Node MCU, a wireless sensor network to transfer the data acquired from the machine to an interface called "thingspeak". This interface displays the data in the required format such a digital display, analog display, and using guage types, thus making it easier for the user to clearly identify the output of the system.

6. CRITERIA FOR ASSESSING SOLUTIONS

The proposed solutions assessed based on the it's applicability, suitability for remote locations and form factor of the final product. The entire circuit diagram is shown in figure 4

.

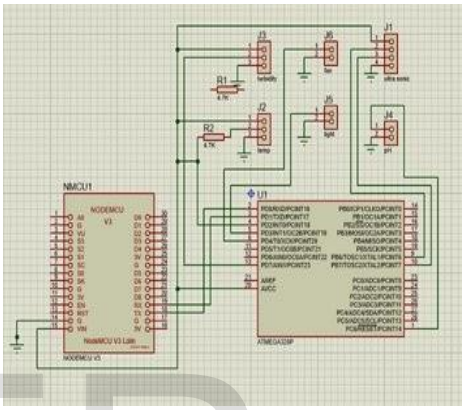

Figure 4. Arduino index circuit boards

The temperature sensor, turbidity sensor, ultrasonic sensor are connected to it. The temperature sensor is a one wire waterproof temperature sensor that measures temperature with a minimal amount of hardware and wiring. This sensor uses a digital protocol to send accurate temperature readings directly to the NodeMCU without the need of an analog to digital converter or additional hardware.

An analog pH meter is used here; it has an LED which works as the power indicator, a bayonet neill– concelman (BNC) connector and pH sensor interface. To use the pH sensor, it needs to be connected with a BNC connector

Calibration should be performed when used in a new environment. A water safety sensor was used to detect water quality with turbidity measurement. It uses light for detecting the floating particles in the water by measuring the light transmittance and scattering rate. As TSS increases, the turbidity of fluids increases.

7. ANALYSIS AND INTERPRETATION

The proposed system was successfully developed using the proposed hardware, software and architecture. The data is transmitted regularly, without errors and with a very small latency. The system was tested using the system in a local network.

There is the box with its four sensors, the Node MCU and the and the PCB. This box is placed near the tank to

which it will be measured its water quality and the three sensors are immersed in the tank. This 15 seconds counter is used to take the measurements every 5 seconds. A request is sent to a sensor to take the measurement and when the request of each sensor is sent, the sensed information is sent to the application. The complete implementation of the circuit and its companion app is shown in figure.5

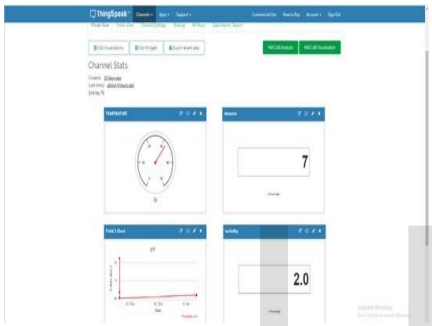

Figure 5: Application UI

8. CONCLUSION AND RECOMMENDATION

Based on an IoT solution, this project proposed the Fish monitoring system that allows the aquarium sensors to drive the actuators in real time. Fish monitoring is one of the emerging issues in the world of aquaculture and it has become extremely important to increase productivity.

In this project, Monitoring of Turbidity, PH Temperature of Water makes use of water detection sensor with unique advantage and existing technologies. The system can monitor water quality automatically, and it is low in cost and does not require people on duty. So the water quality testing is likely to be more economical, convenient and fast. The system has good flexibility. We showed how to intelligently feed the fish through a combined automate and manual control mechanism such that the fish are neither over nor under fed, and at the same time, the fish owner can enjoy watching fish feeding remotely. Our solution allows the designer to quickly deploy intelligent control for various water conditions.

In this project we designed a Fish monitoring system based on arduino. Node MCU and android app or Thingspeak. In future we can add machine learning algorithms to evaluate the health based concepts like analyzing the hungry of fish.

ACKNOWLEDGMENT

The authors acknowledge support from the DST-NIMAT Sponsored IoT Cloud Entrepreneurship program in IIIT- Kottayam.

REFERENCES

[1] YI-BING LIN, HUNG-CHUN TSENG, "FishTalk: An IoT-Based Mini Aquarium System" IEEE Access, vol. 7, DOI 10.1109/AC-CESS.2019.2905017, Taiwan, 2019.

[2] Mehboob Hasan Rohit, Zarin TarannumHoque, S M Mujibul Karim, Dr.Shahnewaz Siddique, "Cost Effiecient Automated Pisciculture Assistance System Using Internet of Things(IoT)" IEEE, DOI: 10.1109/SERP4IoT.2019.00015, Bangladesh, 2019.

[3] Cesar Encinas, Erica Ruiz, Joaquin Cortez and Adolfo Espinoza, "Design and implementation of a distributed IoT system for the monitoring of water quality in aquaculture" IEEE Xplore, DOI: 10.1109/WTS.2017.7943540, Mexico,June 2017.

[4] Guandong Gao , Ke Xiao, Miaomiao Chen, "An intelligent IoT-based con- trol and traceability system to forecast and maintain water quality in fresh- water fish farms"Elsevier,ttps://doi.org/10.1016/j.compag.2019.105013, China, September 2019.

[5] Nocheski S, Naumoski A, "WATER MONITORING IOT SYSTEM FOR FISH FARMING PONDS" International Scientific Journal "Industry 4.0", Year III, Issue 2, p.p. 77-79 (2018).

[6] B. Durga Sri, K. Nirosha, P. Priyanka, B. Dhanalaxmi, "GSM BASED FISH MONITORING SYSTEM USING IOT" International Journal of Mechanical Engineering and Technology (IJMET), Volume 8, Issue 7, pp. 1094–1101, India, July 2017.

[7] S.Balakrishnan, S.Sheeba Rani, K.C.Ramya 2, "Design and Develop- ment of IoT Based Smart Aquaculture System in a Cloud Environment" International Journal of Oceans and Oceanography, ISSN 0973-2667 Volume 13, Number 1 (2019), pp. 121-127 , January 2019.

[8] Zheng Jiangbin, Chen Rui, Zhu Hao, "Intelligent Fish Tank Con- trol System Based on Internet of Things Cloud Computing Platform" https://doi.org/10.1145/3284557.3284737, china, 2018.

[9] Lorena Parra, Sandra Sendra, Laura Garc´ıa, and Jaime Lloret, "Design and Deployment of Low-Cost Sensors for Monitoring the Water Quality and Fish Behavior in Aquaculture Tanks during the Feeding Process" DOI: 10.3390/s18030750, March 2018.

[10] N Vijayakumar, R Ramya, "THE REAL TIME MONITORING OF WATER QUALITY IN IoT ENVIRONMENT" International Conference on Innovations in Information,Embedded and Communication systems, DOI; 10.1109/ICCPCT.2015.7159459, India, July 2015.

[11] Wanda Vernandhes, N.S Salahuddin, A. Kowanda, Sri Poernomo Sari, "Smart Aquaponic with Monitoring and Control System Based On IoT" IEEE, DOI: 10.1109/IAC.2017.8280590, Indonesia, February 2018.

[12] .Francis E. Idachaba, Joseph O. Olowoleni, Augustus E. Ibhaze, OluyinkaO. Oni, "IoT Enabled Real-Time Fishpond Management System" World Congress on Engineering and Computer Science Vol I, 2017.

[13] A. Zaini, A. Kurniawan, A. D. Herdhiyanto, "Internet of

Things for Monitoring and Controlling Nutrient Film Technique (NFT) Aquaponic" IEEE, DOI: 10.1109/CENIM.2018.8711304, Indonesia, May 2019.

[14] T. Abinaya, J. Ishwarya, M. Maheswari, "A Novel Methodology for Monitoring and Controlling of Water Quality in Aquaculture using Internet of Things" IEEE, DOI: 10.1109/ICCCI.2019.8821988, India, September 2019.

[15] Jui-Ho Chen, Wen-Tsai Sung* and Guo-Yan Lin, "Automated Moni- toring System for the Fish Farm Aquaculture Environment" IEEE, DOI: 10.1109/SMC.2015.208, China, January 2016.

[16] Flordeliza L. Valiente, Ramon G. Garcia, Ellaine Joy A. Domingo, Scott Martin T. Estante, Erika Joanna L.Ochaves, Julian Clement C. Villanueva, Jessie R. Balbin "Internet of Things (IOT)-Based Mobile Application for Monitoring of Automated Aquaponics System" IEEE, DOI;10.1109/hnicem.2018.8666439, 2018.