# Cost Efficient Automated Pisciculture Assistance System using Internet of things(IoT)

Mehboob Hasan Rohit
Department of Electrical and Computer Engineering
North South University
Dhaka,Bangladesh
mehboob.hasan@northsouth.edu

Zarin Tarannum Hoque
Department of Electrical and Computer Engineering
North South University
Dhaka,Bangladesh
zarinesterik@gmail.com

S M Mujibul Karim
Department of Electrical and Computer Engineering
North South University
Dhaka,Bangladesh
mujibul.karim@northsouth.edu

Dr.Shahnewaz Siddique
Department of Electrical and Computer Engineering
North South University
Dhaka,Bangladesh
shahnewaz.siddique@northsouth.edu

***Abstract*— The more the technology is getting advanced, the more it makes the life of people depending on it and one of that technologies is automation. Internet of Things (IoT) is another term which envisions every physical object that are being connected to the internet and being able to identify themselves to other devices. This paper illustrates a methodology to provide a low cost Automated Pisciculture Assistance System for indoor fish production using Wireless Fidelity (Wi-Fi). Despite being ranked third in the world in terms of inland fish production [1], Bangladesh is presently using the method of Recirculation Aquaculture Systems (RAS), because pollution of pond water is a major factor posing significant danger to hygiene issue for fish population inhabiting in pond water. In this research we have developed a complete assistance system which gives update to the user of the conditions of the water through the sensors and operate the device remotely. The key components of this system are a pocket-sized Wi-Fi module, Message Queuing Telemetry Transport (MQTT) for monitoring, controlling the sensors and alerting the user through SMS, an Android application to visualize the data provided by the module and to operate the device. Our main objective was to design a system to overcome the downsides with minimal costing and easy installation process.**

***Keywords*— *Internet of Things (IoT), Wireless Fidelity (Wi-Fi), Pisciculture Automation System, Wi-Fi module, Android, Sensors.***

## I. INTRODUCTION

Bangladesh is a low-lying riverine country located in southern Asia. About seven percent of the total area of Bangladesh is covered with rivers and inland water bodies [4]. The favorable geographic position of Bangladesh comes with a large number of aquatic species and provides plenty of resources to support fisheries potential. Fish is a popular complement to rice in the national diet, giving rise to the adage “a Bengali is made of fish and rice.” Not only a major part of the population lives on fish but also Bangladesh earns a considerable amount of foreign currencies by exporting fish and other fisheries products. There are, however, serious concerns surrounding the slow decline in the condition of open water fish stocks which have been negatively impacted upon through a series of natural and anthropogenic induced changes including large scale abstraction of water for irrigation and the construction of water barrages and dams, human activity resulting in the over exploitation of stocks, the unregulated introduction of exotic stocks and pollution from industry.

Now a day it has been very difficult to maintain a healthy water for fish production, for that people are now showing more interest to grow fish in a confined environment. One of the methods to grow fish in an indoor environment is Recirculating Aquaculture System (RAS) which rears fish at high densities, in indoor tanks with a controlled environment. Recirculating systems filter and clean the water for recycling back through fish culture tanks. New water is added to the tank only to make up for splash out and evaporation and for that used to flush waste materials. Fish grown in RAS must be supplied with all the conditions necessary to remain healthy and grow. They need a continuous supply of clean water at a temperature and dissolved oxygen content that is optimum for growth. Water pH need to be maintained in order not to be acidic water due to the excretion of fishes. The fish must be fed a nutritionally-complete feed on a daily basis to encourage fast growth and high survival. There are machines which already serves these necessities, but they are heavy weight and bulky in size and they are operated manually. It would have been much more comfortable if it could be both monitored and operated automatically.

Internet helps us to bring in with immediate solution for many problems and also able to connect from any of the remote places which contributes to overall cost reduction and energy consumption. IoT is a system that uses computer or mobile devices to control basic functions and features automatically through internet from anywhere around the world. With the introduction of IoTs, the research and development of automation are becoming popular in the recent days. Thus, the idea came up to make a unique system that can give update about the condition of the water in an Android application that would be sensed through sensors(temperature,pH,turbidity) and operate the appliances that are involved with fish production(oxygen pump,light,feeder,heater) remotely and as added bonus features ,scheduling the events was also included.

## II. PROBLEM STATEMENT

Problems related to the quality of water in pisciculture systems are very diverse. A careful balance of nutrients and other factors is essential to maintain the optimum culture conditions required for fish health. These factors include temperature, pH, turbidity, transparency, hardness, the balance between oxygen and carbon dioxide etc. In our system we have mainly focused on those parameters of which fish health is mostly dependent.

Temperature affects the water quality. The metabolic rate of fish increases as with the temperature. Therefore, temperature has a direct effect on important factors such as growth, oxygen demand, food requirements and food conversion efficiency. The higher the temperature, the greater the requirement for oxygen and food and the faster the growth rate. If the temperature is low, it can hamper the growth along with the health of the fishes by various diseases [6]. For that a standard temperature should be maintained as of mentioned in Table I.

Changes in pH also affects the fishes. Lower concentration of pH can accelerate the release of metals (copper and other heavy metals) from rocks and sediments which can affect the metabolism of the fish and its ability to take up water through gill [8]. Fishes are prone to attack of parasites and diseases in acidic waters. When pH rises over 11, the gills and lens and cornea of fish eyes are destroyed [7]. Due to waste discharge of the factories the required pH of the water gets reduced [3], the temperature of water fluctuates [2] which causes the death of fish. High pH also makes the toxic form of ammonia more prevalent.

TABLE I. Water quality standards for fish production [5]

| **Parameters** | **Acceptable Concentration** |
|---|---|
| DO | >5 mg/L |
| pH | 6.5-8.5 |
| Temperature | >20° C for warm water species<br>15-20° C for cool water species |
| COD | 20-30 mg/L |
| TSS | >80 mg/L |
| Nitrite | <0.02 |
| Nitrate | 0-100 |
| TAN | 0-0.2 |

Dissolved oxygen is considered as one of the important aspects in pisciculture. There is an inverse relationship of oxygen and temperature. At day time there is an increase of oxygen but at night there is a decrease of oxygen. It is needed by fish to respire and perform metabolic activities. Thus, low levels of dissolved oxygen are often linked to fish kill accidents. On the other hand, optimum levels can result to good growth, thus result to high production yield.

Fishes need to be fed a fix amount of food daily. The metabolism of fish is controlled by their surrounding temperature, the lower the temperature lower the digestive time. Also, most of the fishes do quite well on one feeding per day. So, if excessive of food is given to fishes, they may die of eating a lot at once.

Turbidity is a measure of how particles suspended in water affect water clarity. It is an important indicator of suspended sediment and erosion levels. Sometimes the water become muddy due to excessive rainfall or water becomes green because of way too much algae in water which affects the fish health.

The optimum fish production is totally dependent on the physical, chemical, and biological qualities of water to most of the extent. Hence successful pisciculture management require an understanding of water quality and to provide high quality water we have built this automated assistance system.

## III. EXISTING SYSTEM

The industry and the Academicians have worked together in perfect harmony to make great advances in the field of automation system. There are many technologies that are already involved with pisciculture but none of them are automated which requires more human effort. To monitor and operate the user needs to go in person which takes a lot of time as well. There already exists such components that can be used individually for that certain purpose. But they are not functionable in a single device which makes them costly in order to use in an indoor fish farm. Most of the systems are very bulky and heavy weight. In order to accommodate in an indoor environment, they require large space which sometimes becomes very hard to provide.

Use of IoT technology to reduce energy consumption is one of the challenging tasks because it becomes more hectic in busy life if user fails to turn off the appliances which may create the problem of loss of electricity. To achieve effective solution to these problem one such automation is required which allows the user to manage appliances remotely without their physical presence. Also, there are problems with automation as it faces the main problems costing, manageability, and security.

## IV. PROPOSED SYSTEM

In this paper we have introduced a system which is very light weight and easy to carry. It can be installed anywhere without having less complications as it is a compact device having four small sensors and a relay with which the other appliances are going to be connected that could be operated remotely.

A user can be updated about the conditions of the water anytime as it will be showing the temperature, pH, turbidity, and percentage of water damage in an android application and if required he/she can activate the switches of certain appliances of whose functionalities need to be performed by using the app.User can also schedule the events when he/she is away for a long time. If any abnormalities are seen in the water the user will be notified through an SMS.

## V.SYSTEM DESIGN AND IMPLEMENTATION DETAILS

### *A. Hardware Part*

In this system NodeMCU is at the center of the system which is based on ESP8266-12E Wi-Fi module shown in Fig. 1. It is a low cost and highly integrated chip that can be configured to connect to the Internet for Internet of Things (IoT) technology. The temperature sensor, turbidity sensor,4 channel relay is connected to it.

Fig 1. Node MCU

The temperature sensor DS18B20 is a one wire temperature sensor that measure 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 other extra hardware. We have made this sensor waterproof by inserting it into a small waterproof stainless package just like Fig. 2

Fig 2. DS18B20

An analog pH meter is used here which has a built-in simple, convenient, and practical connection and features. It has an LED which works as the power indicator, a bayonet neill–concelman (BNC) connector and pH2.0 sensor interface just like Fig 3. To use the pH sensor, need to be connected with BNC connector and plug the pH2.0 interface into an analog input port. It needs to be calibrated whenever it is going to be used in a new environment.

Fig 3. pH sensor

We have used water turbidity sensor to detect water quality by measuring the levels of turbidity. It uses light to detect suspended particles in water by measuring the light transmittance and scattering rate, which changes with the amount of total suspended solids (TSS) in water. As the TSS increases, the liquid turbidity level increases.

Fig 4. Turbidity sensor

Here, 4 channel 5v opto isolated relay is used to connect oxygen pump, light, feeder, and heater in the system. These appliances will be activated whenever they will receive data from the NodeMCU through android application and also, they will be activated automatically if the events(on/off) of these appliances are scheduled.

Fig 5. 4 channel relays

To design an automated water pump we have used a 12v relay, a standalone microcontroller and liquid level probe. There are 3 wires in the liquid level probe. Among them, one is for detecting when the water tank is full, so that the water pump will be turned off automatically and other one is turning on the water pump whenever the water gets down of it as shown in Fig. 6

Fig 6. Automated water pump mechanism

### *B. Proposed IoT Architecture*

In this system NodeMCU is the main controlling unit which can connect with the smart phone application with the use of internet to control the peripheral devices along with getting the data from the sensors as shown in Fig. 7. With the help of internet, MQTT [9] is used to deliver the data from the NodeMCU to the android application and the website of it. It is used for setting the triggering conditions and controlling the appliances as well if any abnormalities happen in the water health, the user will be notified by an SMS. For customizing the messages, we have integrated the SMS service of Webhook applet of IFTT which supports the IoT based systems. [10]

The turbidity sensor is calibrated within the system with the help of MQTT in the range of 0-5v shown in Fig. 9. As shown in Fig. 8, the water turbidity has a relation with the voltage which is applied in our system to calibrate it.

To get analog pins, ADS1115, an analog to digital converter is used here as analog sensors (pH, turbidity) need to be connected to NodeMCU. Also, the analog pins of Node MCU serves 10-bit data and ADS1115 serves 16 bit-data for which it gives more accurate and efficient data. Thus, ADS1115 is used in the system for getting accurate data from the sensors. Also, a logic level shifter is used in the system as ADS1115 does serial communication and it is obvious the other device connected to it need to be operated in the same voltage. But NodeMCU can operate only in 3v but to serial communicate with ADS1115 it needs to be operated in 5v as well as to get the data from the sensors which is of 5v.

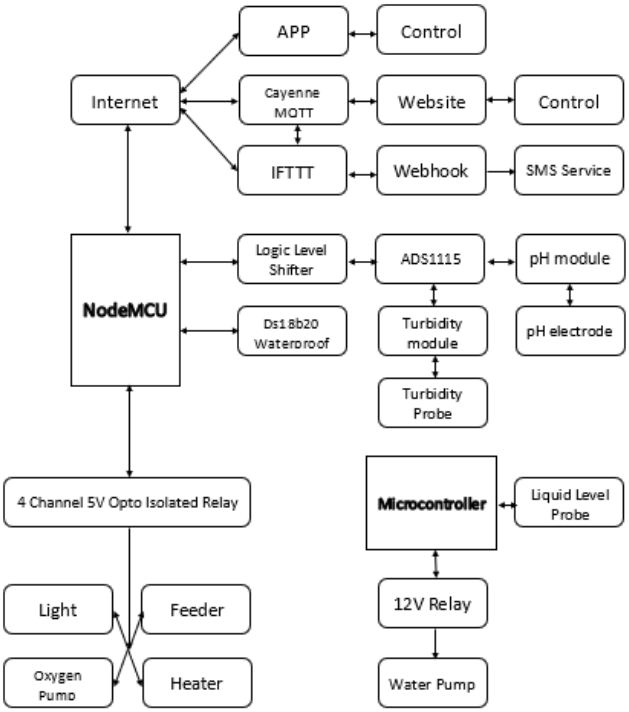


Fig 7. IoT architecture of the proposed system

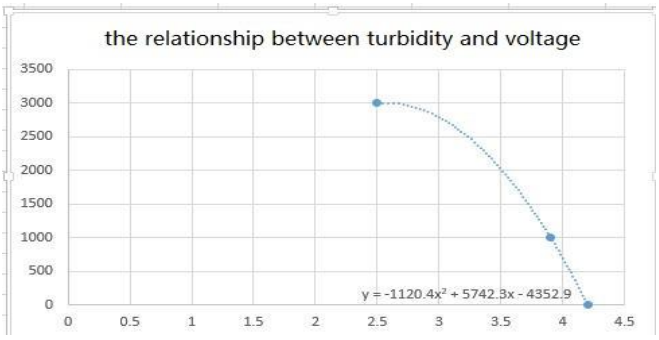


Fig 8. Relationship between turbidity and voltage [11]

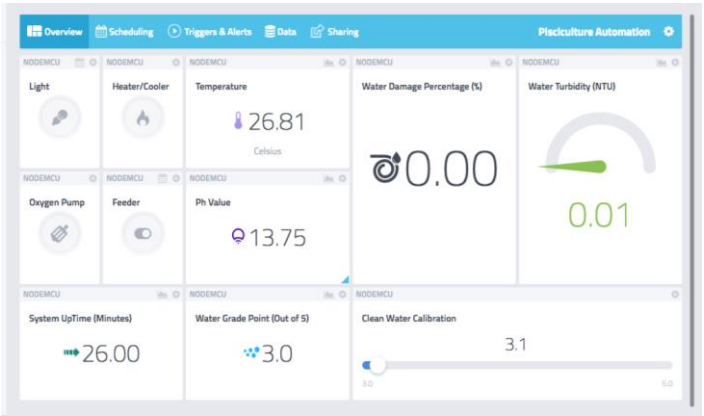


Fig 9. MQTT broker interface of the system

### *C. User Interface*

To operate the device remotely and to visualize the readings that we will be getting from the sensors in real time there is an app designed for the user. As shown in Fig. 10, in the first page of the app the user will be updated about the different parameters of the water e.g. temperature, pH, turbidity, water damage percentage through internet and in the second page of the app there are buttons of four appliances to turn on/off them remotely.

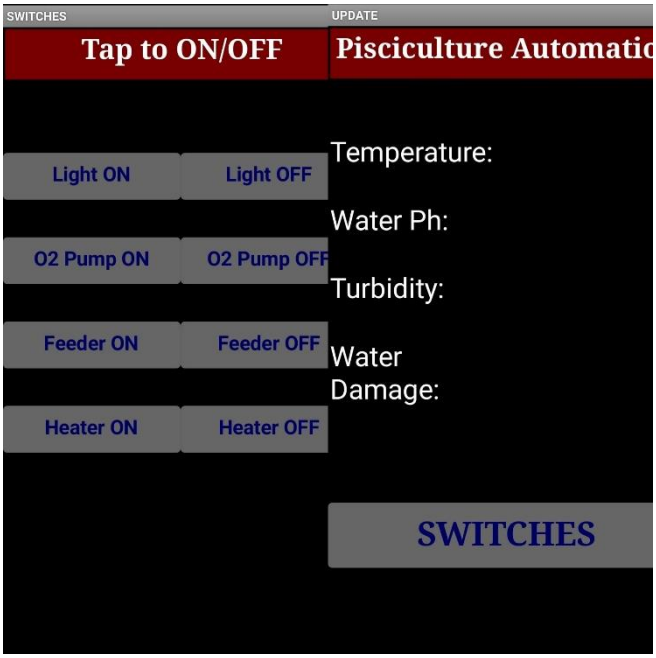


Fig 10. Android app for the system

## VI.RESULTS AND DISCUSSIONS

Main aim of the system was to make it cost efficient and small in size, so that anyone can afford it. Because most of the people who are involved in pisciculture are from poor family or middle-class family. In order to make it cost efficient as well as a compact device we have implemented the hardware part shown in Fig. 11, according to the design of the system, so that in can be installed anywhere very easily.

The pH sensor that we have used is an analog sensor which has pH module within which there are two pins-offset and limit. For every different type environment water this sensor needs to be calibrated by varying the limit pin.

We have tested our system against different type of environment water and satisfactory results were obtained as the system was built according to the plan. In the android application update of different parameters of the water were correctly displayed, shown in Fig. 12. The water pump worked very smoothly as per the need and also the appliances were operated remotely without having any difficulty. As all the outputs are shown in the smartphone instead of LED screen on dashboard which reduces the cost and makes the system installation easy.

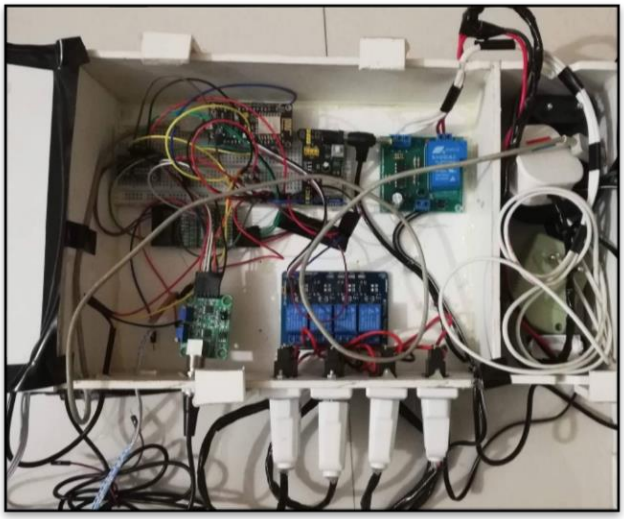

Fig11. Hardware implementation of the system

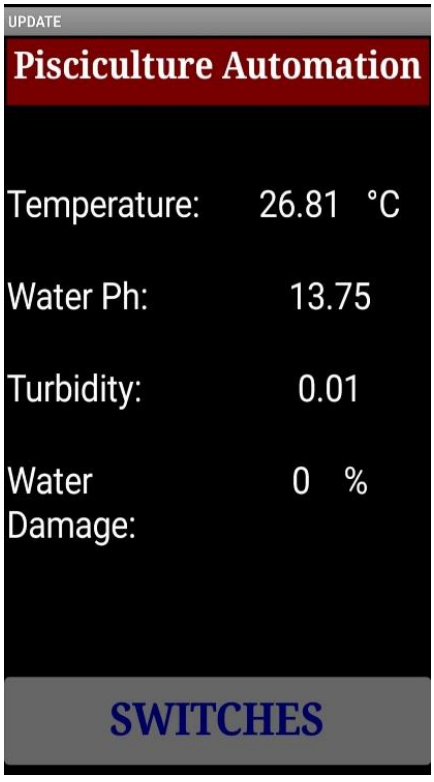


Fig12. Update of water health

The triggering conditions that we have set in the system which can detect any kind of abnormalities in the water and aware the user by sending an SMS was working satisfactorily, shown in Fig13.The system automatically takes necessary actions that we have already set in the system when it meet its triggering conditions.Also,the events can be scheduled rightly if the user is away for a long time, shown in Fig14.So,there is no option left that can harm the fishes anymore.

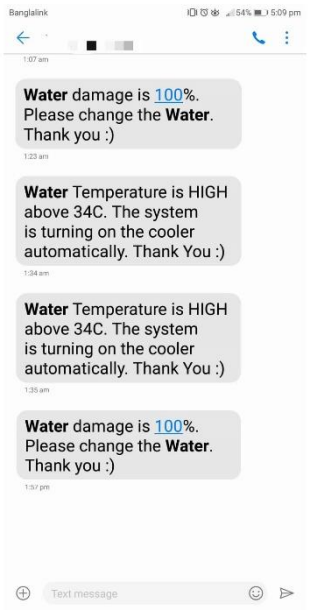


Fig13. Notification message received on user's cell phone

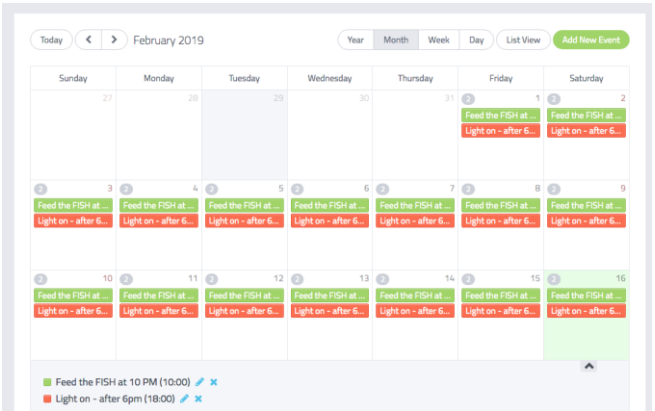


Fig14. Scheduled events.

This system can be used in outdoor fish farming as well by developing a bit. As it requires very less human engagement, it saves a lot of time as well as ensuring the proper growth and health of the fishes.

## VII.CONCLUSION

This system can significantly improve the overall pisciculture system. The usage of smartphones which are used by almost everyone nowadays due to lesser cost and some easily available devices makes the system affordable. The user-friendly application interface conveniently helps the

user to be in control of most situations by assisting him/her in every way. Our goal is to ensure healthy water for fishes altogether but even in case of unhealthy situations taking proper actions will become easier than ever.

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