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# Monitoring of Water Quality of Aquarium by Using IoT Technology

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**Abstract:** Marine life in aquarium are continuously producing harmful impurities and proteins which should be continuously removed is considered as a big problem in today's aquariums. The water is equally important for living lives. The marine life requires equal attention for clean environment. The impurities in existing aquarium creates threat for the life of marine in result, fishes could not survive and could die as well, also for existing aquariums the removing impurities from water in the aquarium is a crucial issue. Frequent testing of water quality parameter such as Turbidity sensor to detect the suspended particles level in the water. This system will help the aquators to avoid the manual work and generate a balanced system where fishes can be survivable. This system is based on low cost electronic sensor level detection, an automated concentration measurement system is introduced to monitor the bad water quality that affect the health of fishes we propose an IOT based solution. This whole system is automated and give wireless control with the help of WIFI. The results are shown via webpage.

Keywords: Water Quality, IoT System, Aquarium, Sensors

## 1. Introduction

In nineteenth century aquaria was used by Jeanne Villepreux-Power a French biologist who was experimenting with aquatic organisms. After that Dr. Nathaniel Bagshaw Ward imitated in using tank for purpose of animals in 1836 [1]. In 1846, Anne Thynne was the one who ascribed as a creator of first balance marine aquarium in London. Because of keeping stony corals and seaweed for three years [2]. The very first experiment on making stable aquaria was done by English chemist Robert Warrington withal 13-gallon container which include goldfish, eelgrass, and snails. in 1850, Warrington bring out the principle of the aquarium in the Chemical Society's journal. In which he described that plants added to water in a container would give off enough oxygen to hold up animals as their numbers do not grow too large [3]-[5]. In 1853, Philip Henry Gosse made and merchandise the first public aquarium in the London Zoo, known as fish house. Henry Gosse coined the word "aquarium" here aqua means "water" and rium means "place for related to". The Jardin zoologique at the Bois de Boulogne included an aquarium that housed both fresh and saltwater animals [6]. Freshwater aquarium includes one or more freshwater aquatic organism for decoration this this includes cold water and tropical water. Cold water Aquarium have no

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requirement of heating apparatus for fishes an in tropical water maintained a warm environment keeping temperature about 75 to 80 F.

The recent invention of aquarium system is used to display the marine life. the water must be filtered and impure less to keep the marine life healthy [7]. Marine life in aquarium are continuously producing harmful impurities and proteins which should be continuously removed is considered as a big problem in today's aquariums. Decaying food and the waste matter can produce ammonia and nitrogen compounds which are considered as poisoned to aquatic animals if assembled in the aquarium. Since 1930, live fish have been legally collected for aquarium and live reef fish for food. But in 1960, a Philippines's local fish collector used sodium cyanide to layout and collect the desired fish. It was reported that in at least 15 countries there is a illegal use of cyanide for fishing as it is toxic for fishes as well as for all the human beings.

To solve the problem of water quality of aquarium by using turbidity sensor to measure the purity of water to get to know that water is pure or not for fish's survivability. To reduce manual work of cleaning water here will be using filter. Water pollution data will be shown on LCD as well as on web page on testing basis. If the water is polluted, then filter will be on.

This water is equally important for living lives. The marine life requires equal attention for clean environment. The impurities in existing aquarium creates threat for the life of marine, in result fishes cannot survive and could die as well, also for existing aquarium's the removing impurities from water in the aquarium is the crucial issue. The level of PH of water, amount of dissolved oxygen in water, number of suspended particles in the water, temperature of water and so on is very much important to record as well as control to save marine life. Furthermore, the manual changing of water level and its testing take plenty time and efforts.

The proposed system will design an automated system to intimate the water quality of Aquarium. The system will analyze the parameters for measuring water quality and design a system to check the water quality, to intimate the person by alarming him to change.

## 2. Literature Review

The different work has been referred in carrying out this work related to aquarium system. Author Dana Macfarlane in [1] did a research in 2017 in which the parameters are comprise that is PH, turbidity, conductivity, nitrate , nitrate and dissolved oxygen and these parameters were introduced .by using different experiments which was directed using mice in water samples collected from the Schuylkill river in Philadelphia, US, as well as deionized water for control for the completion of the experiment three months later. In [2] Author A .Arun Gnana raj propose a system that using raspberry pi that monitor a green house, poultry and a fish tank that monitor and control the environment by IoT sensors and actuators that are the key components to monitor and react for the environment. This system based on the automation of fish tank that allow the holding between the surroundings and recover or reuse the wastes from one environment to another. This solution help us to monitor and maintain the green farm, poultry and fish tank and automation will measure the amount of waste and reduce the cost of management. In [3] Author M. Manju proposed a system which was used to produce organic food and monitor the quality of water continuously at daily bases to reduce the manual doing tasks by using IoT application to improves the efficiency of the system by using different sensors that can accessed remotely by using IoT. In [4] Author shiny Abraham proposed a system by monitoring of water quality of aquarium by using IOT by using different water quality sensors that provide continuous and real time information by using raspberry pi that will ease to maintenance of growth of fishes to healthy ecosystem . Where in [5] AUTHOR An-Bang Cheng1 has proposed the system about the monitoring of water quality of aquarium that uses parameters for safe environment which are temperature, dissolved oxygen and PH by using IOT that will monitored online and display on the LCD that is interface of the sever device .if current climate conditions continue then some infrastructure changes are needed to improve the situation. AUTHOR T. ABINAYA in [6] has proposed a system that he discussed

about the monitoring and controlling of water quality of aquarium by using IOT based system . It is important that if the water quality is good in the aquaculture then there is a good return or yield of fishes . In [7] AUTHOR DR GS did a research about the usage of internet of things for water quality and flow management. Using Ph, IR, Raspberry Pi. This provides smarter, low powered water management system with high mobility and efficiency. Finally, all these features form a complete package for smart water management using IOT applications. AUTHOR MOURIKA SHIRODA in [8] proposed a system by which monitoring of the water quality measuring system by using IOT technology that checks the water quality measurement by using different sensors i-e PH , temperature, conductivity and turbidity. These parameters measure the water quality of aquarium in real time. And Nodemcu (WIFI module) is used as a microcontroller that transfer the data to the mobile or PC . In [9] Author B. Siregar did research on one technology that is hydroponic or aquaculture farming systems is sensing that can be applied. In this system the parameters are used that are pH, electrical conductivity, water level, and temperature sensor. All the data at the output are represent in graphical form in which there is a two conditions. The first come first temperature is used for plotting the data. and it will done on serviced processor that data entities must wait until the previous processes have been completed . In [10] AUTHOR BHARTI SEGUPTA has proposed a system that discussed monitoring and controlling the water quality of aquarium by using IOT technology, good efficiency and flexible that uses in many fields like industries and distribution system of water that design and development of a low-cost system for real time .HIGH efficiency and flexible. in [11] AUTHOR Muhammad Aziz Muslim has proposed the system which is based on the controlling of water quality of aquarium by using filter pump based on the fuzzy logic. He used parameters that is temperature and PH. And the fuzzy logic is used as a controller that provide energy or strength of filter pump on which the the turbidity level of water information is obtained . at the end the results show that the fuzzy logic controller can improve the water quality level in a short time .and the system performance was good even in the existence of disturbance. In [12] AUTHOR Amaranth Varma Angani has proposed a system about the controlling of smart fish aquarium by using IOT technology that recycling system of water reduces the wastage of water in which the sensors are used that play a important role for improving the quality of water of smart fish farm. And these sensors are PH , dissolved oxygen , temperature . the PID is used as a controller that regulate the water flow process. In [13] AUTHOR Yi-Bing Lin has proposed a system about monitoring of water quality of aquarium by using IOT technology called IOT Talk to improve the water quality of aquarium in this paper different sensors are used to check the quality of water to derive the actuators in real time to give the concrete examples about threshold setting . the various water conditions are set to control that effect the loss on water conditions and IOT message delays. In [14] AUTHOR Abel Kurian omen and Adarsh Saji Shilpa Joseph , Babup Kura Kose proposed a system which gives a technique for food production uses fish wastes as essential nutrients to build an automated water quality monitoring system using IoT.[15] Author Preethm K, Malookarjum B.C, Umesh Mahesh F.M has proposed the system which continuously monitors the water quality parameters using sensors and convey the information via mobile app to reduce the losses and productivity has to be improve and cultivation problem has to be addressed aquarium system automated using IoT declares the energy labor cost and consumption. Author kuttikan methanogen [16] in 2019 has proposed a system that control the aquarium water system using mobile application with IoT based on aquarium fish smart farming and tested with real home mini aquarium that can show the performance and easy use on mobile application. In [17] Author Hyeon Hung Lee has research about main objective is reticulating the water and reduces wastage of water and self-cleaning system for the smart fish farm. In this paper, design and development of open loop type operating system that is recently a new aqua industries. The system design is not carried out via flow control that is costly and wastes high quantity of water. Due to that in this work, the proposed system that is called aquaculture management system that is a new aquaculture system

which is android based that offers clean and clear monitoring of water quality in which fishes are circulating and spending their lives in.

In this work, the automated aquarium system is made so that water will be automatically monitor and clean and fishes can survive.

## 3. Methodology and System Design

This system is divided into five different stages where different task has been done according to our desired result. Each stage defines its working below as shown in Figure 1.

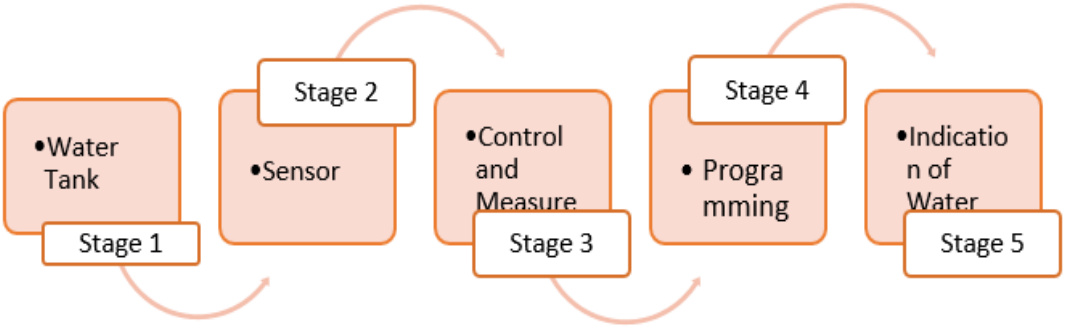


**Fig. 1 –** Methodology for System Design

First the water tank is required to store the water. The quantity of fishes or species in a particular tank that are safe and sound are depend on volume of the tank and also its shape as well. For instance, some of them spend all the life at the bottom of the tank [18]. By twining the volume of the tank doesn't affect the height neither allow you to keep more bottom dwelling fish. The fundamental part is the Surface area than volume in determining how many fish a tank cansupport.as shown in Figure 2

**Fig. 2 –** Water tank used for the prototype

After that sensor will be induced in the tank that is turbidity sensor that senses and returns the type of information from the bodily environment [19]-[21]. Turbidity is the most important parameter of water quality in aquatic environment so for detecting turbidity an instrument was designed [22]. the concentration of turbidity sensor can be sampled and monitored continuously by using turbidity sensor in order to deal with intensity of light that is highly scattered at 90° angle and as a beam of light passes through a water sample as shown in Figure 3.

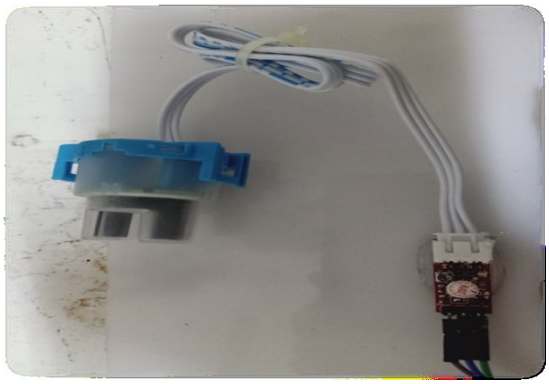

**Fig. 3 –** Sensor used in the prototype

The Node MCU as a controller will monitor and control the sensor readings. It's a single board microcontroller. It has a firmware which runs on the esp8266 [23]-[25]. It has 10 digital pins and one analog pin as shown in Figure 4

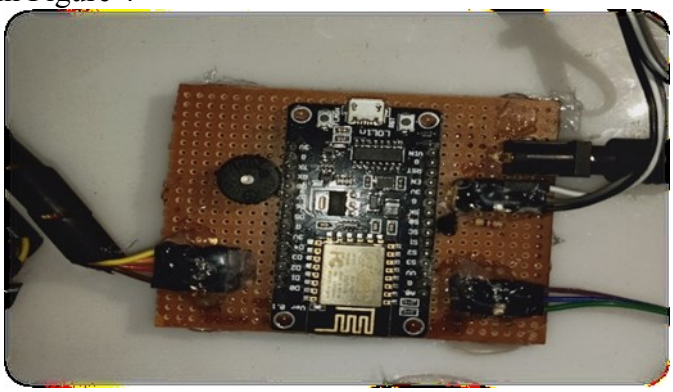

**Fig. 4 – C**ontrol and measurement unit

The programming will acknowledge the water quality measurements. We will load the program onto Node MCU where controlling and monitoring is done. C is used in this work. The code is programmed in different section. Here the flow chart is given where the step is shown according to the water quality condition as shown in the flow chart as shown in Figure 5.

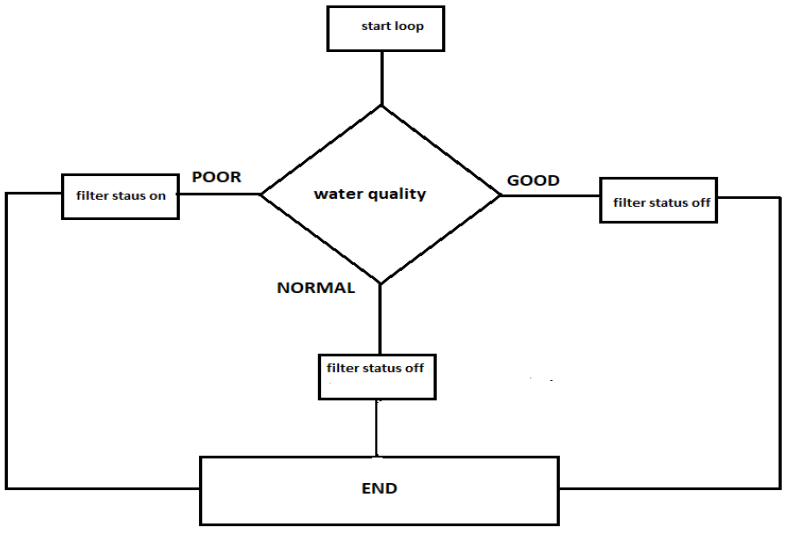


**Fig. 5 –** Flow chart of programming

Indication of Water Quality will be performed by sending information to the Internet. The Web based system collects the data that is provided by the website and exhibited to the specific user that is using the current web browser. Here the output is lcd which shows water pollution in %, relay as a switch for filter, webpage where our results will be shown in digits as shown in Figure 3.6.

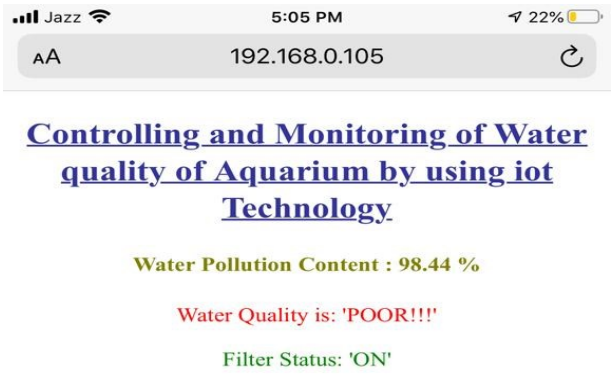


**Fig. 6 –** Indication of water

### 3.2 System Design

The system design methodology is discussed in the diagram as presented in Figure 1. The diagram discussed the various sub-systems that are associated with the design for example, Sensors, Node MCU for Controller, relay use for filter, LCD panel, power supply connections, use of Webpage to show output as shown in Figure 7.

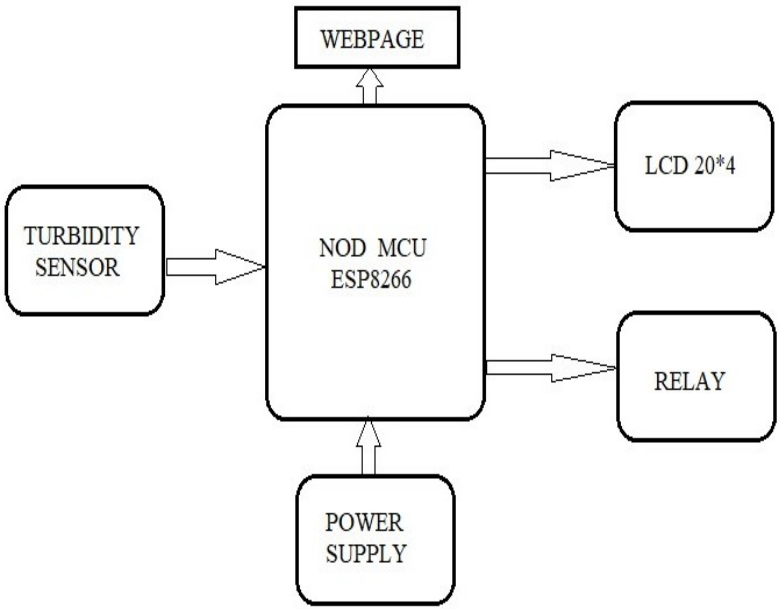


**Fig. 7 –** System Design of proposed system

Hardware is made using different components based on the requirement like first we have used water tank to keep water and then turbidity sensor to detect the pollution then Node MCU as a microcontroller to measure and data cable, jumper wires and power supply for the connections and relay as a switch for aquarium filter pump and buzzer and leds for indication of filter and LCD for showing results [26]-[28]. The simulation is carried out using Arduino IDE software. Where the coding has been done according to our desired results. Here firstly we connected Node MCU through the cable with pc by giving 5v source. And then we choose the Node MCU board and started typing our code according to the output which are three one for LCD where the water pollution will be shown in percentage and second is relay as a switch whenever the water quality is poor the filter will be on and third is webpage where the final output will be shown in the form of status here we have given 3 ranges. If poor then 0, if normal then 50, if good then 100. Water pollution is inversely proportional to water quality, if the water pollution is high suppose 100% water quality is low suppose 0. This is the way codding have been done. Where the sensor is

connected at the analog pin of Node MCU and relay is connected at pin d5, buzzer is connected at pin d7 and LCD is connected at d1, d2,gnd and vin of Node MCU and at GND of relay as shown in Figure 8.

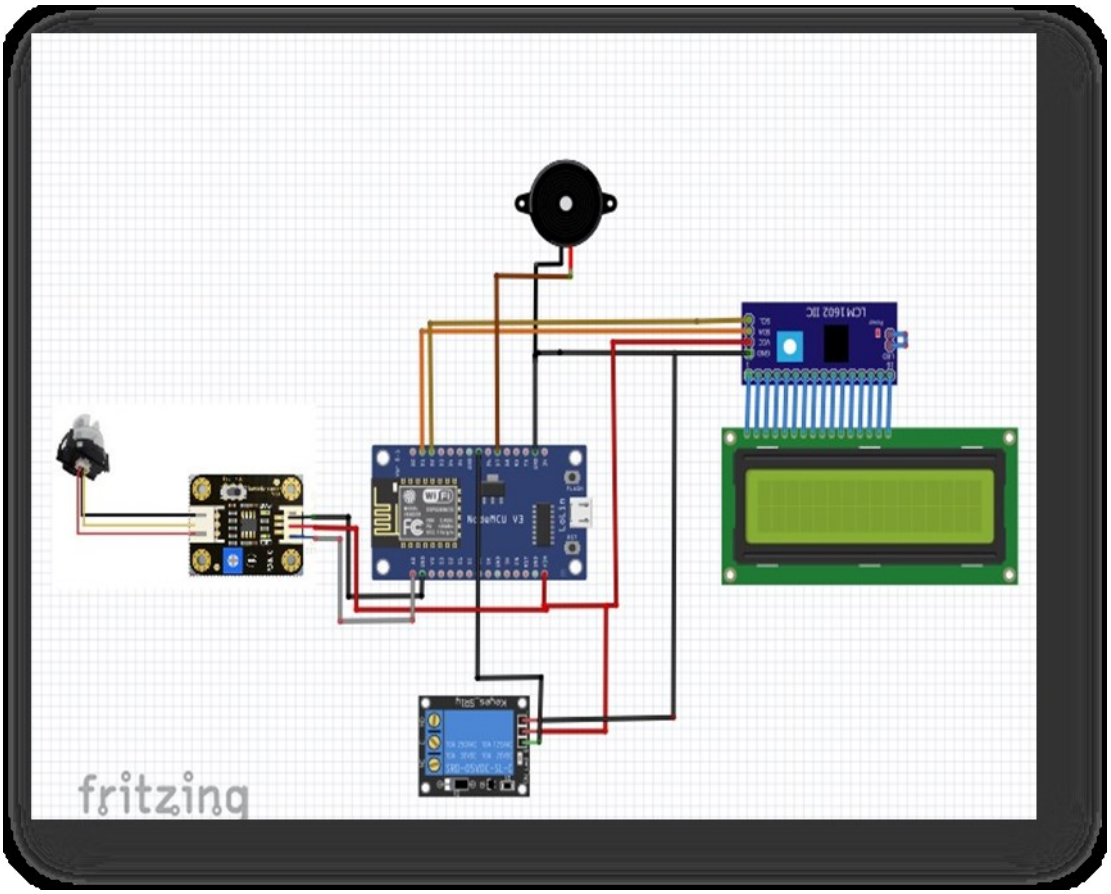


**Fig. 8 –** System Design of proposed system designed using fritzing software

## 4. Results and Discussion

This automated aquarium system is monitored by using IOT technology, which is done by using Arduino ide software where the coding has been done. Coding is done for three output the first result will show on LCD in the form of percentages of water quality and filter status and second output is relay whenever the water quality range is low the buzzer will be on and filter will be on and the third where the overall result will be shown on the webpage, which is done in a way that we have given our hotspot name and password in the coding like this

```
const char *ssid = "Maryam"; // Enter your Wi-Fi Name
const char *pass = "12345678"; // Enter your Wi-Fi Password
```

and we have opened the webpage by giving ip address which will be shown on LCD and the final output is shown on webpage in the form of the water quality status. Water quality rare good, normal, poor and the coding is done in a way like this

```
// declaration of Ranges
int good range =    70.
int normal range = 50.
int poorrange =   0.
```

The range between (0 to 49) % is poor and the filter status will be on. And The second range between (50 to 69) % is normal and the filter status is off

Third range between (70 to 100) % is good and the filter status is off as shown in Figure 9.

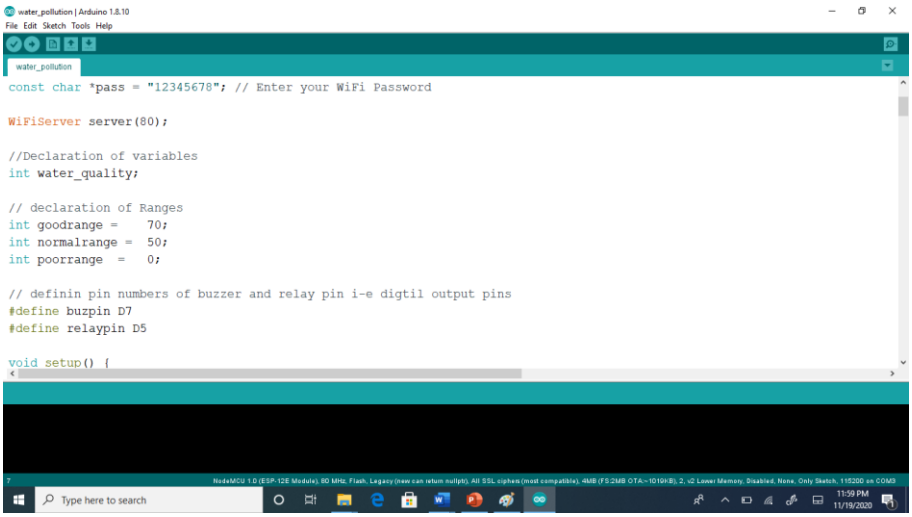


**Fig. 9 –** Arduino IDE software, uploaded code.

When the program is uploaded on the Node MCU and the ip address is shown on the lcd typing that is on the google and the result is being shown on the mobile if the water quality is poor, and the filter status is on and When the water quality is normal the filter status is still off or When the water quality is good, and the filter status is off as shown in the 10.

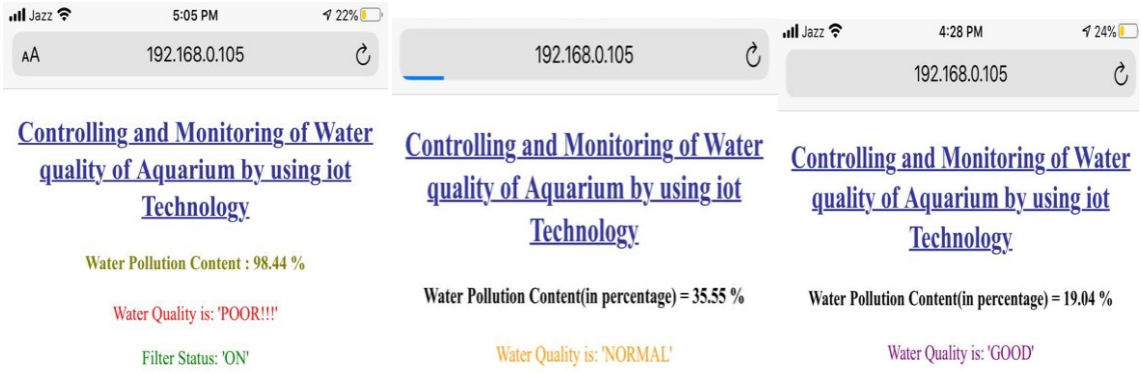


**Fig. 10 – W**ater quality "Poor, Normal and Good as Outcome

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Hardware results are consisting of two sections, On the LCD and Relay as a switch for on and off filter. When the water quality is good and filter status is off. First, taking pure water and putting turbidity sensor in the water to check pollution level as shown in Figure 11.

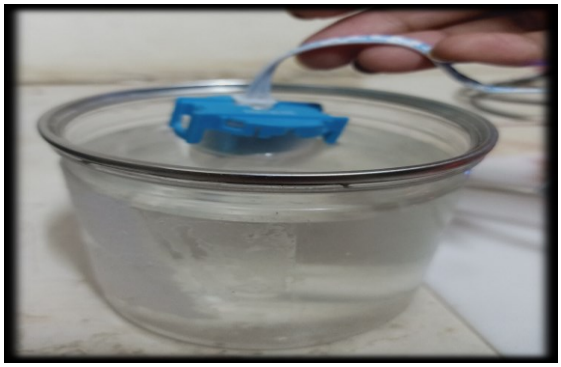

**Fig. 11 –** Checking pure water

Results on lcd showing water quality in percentages and water quality and filter status as shown in Figure 12.

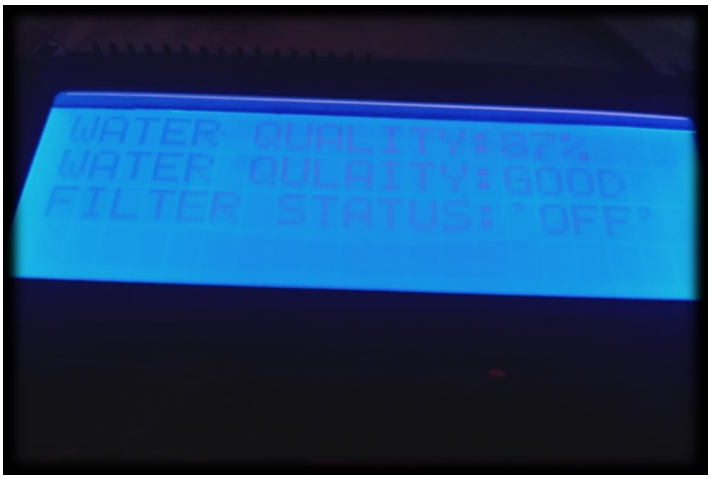


**Fig. 12 –** LCD showing water quality in percentage

When the water quality is poor and filter status is on. Now taking impure water and putting turbidity sensor in the water to check pollution level as shown in Figure 13.

**Fig. 13 –** Checking impure water

Results on LCD showing water quality in percentages and water quality and filter status as shown in Figure 14.


**Fig. 14 –** LCD showing water quality in percentage

The proposed system will help the aquators to avoid the manual work and generate a balanced system where fishes can be survivable. This system is based on low cost electronic sensor level detection, an automated concentration measurement system is introduced to monitor the bad water quality that affect the health of fishes we propose an IOT based solution. This whole system is automated and give wireless control with the help of WIFI. The results are shown via webpage.

## 5. Conclusion and Future Work

In this work, an attempt to create similar clean environment for the marine as for human being needed. But the cleaning process is quite time consuming and in Pakistan there is a lake of automated system, so keeping that in view the authors have developed an automated aquarium system where the testing of water quality parameter will be done here the turbidity sensor that is utilized for measuring the water pollution level and displaying the water quality results on webpage good or bad and automatically clean the polluted water by filter if bad quality and make it survivable for fishes. This system can be design at lager scale for other applications. Enforcement of technologies can improve the quality of life and prepare us towards the smart world. The cost is very low and typically avoids the necessity of manpower and this project will be very economical, convenient and fast and infect this system has so flexibility that if we want to test any other parameter we can change or add the water quality parameter with corresponding sensor and changing related programming code. This system can be expanded to the industry level or agriculture production by adding some new changes and features. Enforcement of technologies can improve the quality of life and prepare us towards the smart world.

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