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# Automated Enhancement of Aquaculture Species Growth by Observing the Water Quality Using Iot

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## ABSTRACT

Aquaculture Species Observing System's main objective is to check the quality of the water by using temperature, pH and turbidity sensors in a water resources i.e. lake, pond. As fish is a significant protein rich food resource and there have been shrilled increase in the demand of fish products due to the increasing population pressure in this century. Thus, to meet the demand of present food supply, water quality management is a necessary step that is required as taken up. The conventional system has some shortness in practice. So, the solution is provided in IoT platform and some additional features have been included in the system for efficient management. Like, the GUI was designed, so that the users and investigators can observe, investigate and analyse the related data. The user interface allows us to convey the analysed data in the form of a message to the users in their respective local languages at their Mobile Phones as SMS and to take necessary steps in unhygienic environmental conditions. With this even semi-literate user can interact with the system and can understand the information to take suitable actions.

***Keywords: pH Sensor, Turbidity Sensor, Temperature Sensor and Internet of Things (IoT).***

## 1. INTRODUCTION

Fish is an inexpensive source of protein and an important cash crop in many regions of the world. Water gives more essential support in which they carry out their life functions such as feeding, swimming, breeding, digestion and excretion. Water quality is one of the important factors to be considered for the distribution, production and reproduction of fish and other aquatic species and at times it may get affected either directly or indirectly. Many workers have reported the status of water bodies after receiving various kinds of pollutants altering water quality characteristics (physical, chemical and biological).

## II. PROBLEM ELUCIDATION

### A. Quality of Aquaculture Species Observing System

All living organisms have tolerable limits of water quality parameters in which they perform optimally. A sharp drop or an increase within these limits has adverse effects on their body functions. Each water quality parameter alone can directly affect the animal's health. Exposure of shrimp and fish to improper levels of dissolved oxygen, ammonia, nitrite or hydrogen sulphide leads to stress and disease. However, in the complex and dynamic environment of

aquaculture ponds, water quality parameters also influence each other. Unbalanced levels of temperature and pH can increase the toxicity of ammonia and hydrogen sulphide.[3] Thus, maintaining balanced levels of water quality parameters is fundamental for both the health and growth of culture organisms. It is recommended to monitor and assess water quality parameters on a routine basis. As we know fish is an important protein rich food resource and there has been sharp increase in demand of fish products due to increasing population pressure in this century.

Thus to meet the demand of present food supply, water quality management in aquaculture species is a necessary step that is required to be taken up. In most of the countries, fishes are cultivated in ponds but unfortunately such culturists are not so aware of importance of water quality management in fisheries. If they are properly guided and made aware about water quality management practices, they can get maximum fish yield in their ponds to a greater extent through applying low input cost and getting high output of fish yield.[2][4]

## B. Methodology

To realize real-time data collection in a secure, robust, manageable and low-cost manner without long-distance cable connections is still a bottleneck in the development of information reviewing in aquaculture. Modern fish culture environment detection and control technology achieves high-quality, high yield, improves the basic environmental conditions and it is one of the key means to promote fish production through the integrated application of bio engineering and computer technology to make the appropriate adjustments, according to the variation of indicators, increase production, and guarantee reliable income.[3] A properly-controlled system will also be energy efficient since production can be optimized with respect to the various inputs. So, a sustainable development of aquaculture environmental factors of observing and controlling system for intensive fish farming is inevitable. pH should be tested at least once a month, preferably every two weeks to allow for detection of trends before they become a problem. Remember that because pH can vary based on time of day, testing at different times of day can yield different results even though nothing is wrong. For this reason, testing should take place in the same day, preferably in the afternoon. [1]

## C. Problem Statement

The biggest problem for most of the aquatic environment will be leaf debris and a proliferation of algae. The water gets decayed if the vegetation falls into the aquatic environment like pond, lake, etc. The process of decay uses the oxygen in the water and releases carbon dioxide. This means that if large qualities of vegetation enter into aquatic environment then enough oxygen can be removed to cause the aquatic wildlife to suffocate.[4] Algae is also caused by decaying vegetation the reason for this is the nitrogen which is released during the decay process is soluble in the pond water. Nitrogen is a nutrient that is essential for plant growth and if there is a lot in the water then it will normally result in algae bloom. Too much algae or sediment in lakes and streams can make them unsuitable for recreation and aquatic life. Turbidity is caused by suspended or dissolved particles in water that scatter light making the water appear cloudy or murky. Water temperature affects the feeding pattern and growth of fish. Fish generally experience stress and disease breakout when temperature is chronically near their maximum tolerance or fluctuates suddenly.

Warm water holds less dissolved oxygen than cool water. Oxygen consumption is directly linked to size of fish, feeding rate, activity level and aquatic temperature. The amount of dissolved oxygen in water increases as temperature reduces, and decreases when salinity increases. Additionally, plants and animals use more oxygen due to increased respiration rates. These factors

commonly result in less available oxygen for fish during the summer and fall months. pH is a measure of whether water is acidic or basic. High or low pH can cause stress to fish and prevents it from reproduction. These problems will directly affect the life cycle of aquatic species.[2]

### D. Difficulties Faced in the System

The water quality monitoring and controlling system for aquaculture is based on wireless sensor networks and single chip computer technology as a base in the actual operation. It monitors the data of water quality parameters such as pH, turbidity, dissolved oxygen and temperature for intensive aquaculture and alarm notification through short messaging service (SMS). [5]

When monitored variables take anomalous values and are suitable for long-term stability under growth conditions thus increasing yield per unit area. This test requires a sample of the water to be taken from the pond and analysis will be conducted on the sample taken. The test is usually to measure ammonia level, pH level and dissolved oxygen level in water. Only trained staff can conduct the test. They have to take a few samples of the water and perform the required test. Each test usually takes between five and ten minutes to accomplish. Test will need to be repeated if samples used are spoiled or no longer usable. Thus, the process is time and cost consuming.

### E. Solution from Survey

Aquaculture Species Observing System automatically checks the quality of water by using pH, turbidity, dissolved oxygen& temperature sensors. Internet of things (IoT) platform has additional features in this system for efficient management. A mobile application is created for the end users to monitor the water quality parameters and to analyze it. Thus the product is less cost and more time efficient.

## III. DESIGN AND WORKING

### A. Hardware Module

The proposed system includes Arduinonano board, pH Sensor, and Turbidity Sensor, Temperature Sensor and ESP8266 Wi-Fi module as shown in Fig 3.1

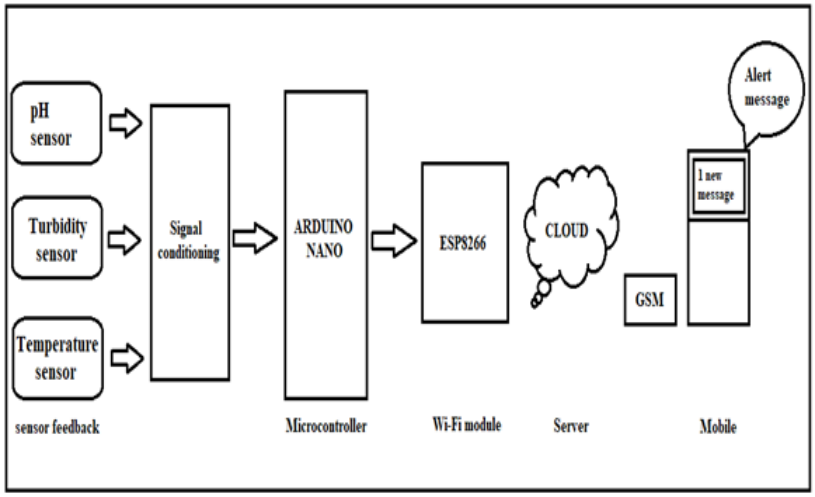


***Fig 3.1: Block Diagram of Proposed System***

1) ***Arduino Nano Board:*** Arduino Nano is a surface mount breadboard embedded version with integrated USB. It is a smallest, complete, and breadboard friendly. It has more analog input pins and onboard +5V AREF jumper. Physically, it is missing power jack. The Nano is automatically sense and switch to the higher potential source of power, there is no need for the power select jumper.

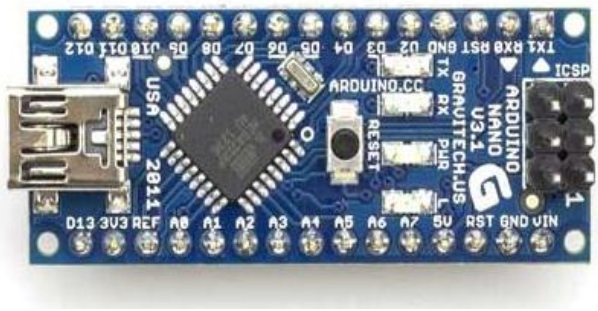


***Fig 3.2: Arduino Nano Board***

**Specifications:**

| | |
|---|---|
| Microcontroller | Atmel ATmega328 |
| Operating Voltage (logic level) | 5 V |
| Input Voltage (recommended) | 7-12 V |
| Input Voltage (limits) | 6-20 V |
| Digital I/O Pins | 14 (of which 6 provide PWM output) |
| Analog Input Pins | 8 |
| DC Current per I/O Pin | 40 mA |
| Flash Memory | 32 KB (of which 2KB used by bootloader) |
| SRAM | 2 KB |
| EEPROM | 1 KB |
| Clock Speed | 16 MHz |

**2) ESP8266 Wi-fi Module:** The ESP8266 is an impressive, low cost Wi-Fi module suitable for adding Wi-Fi functionality to an existing microcontroller project via a UART serial connection. The module can even be reprogrammed to act as a standalone Wi-Fi connected device.

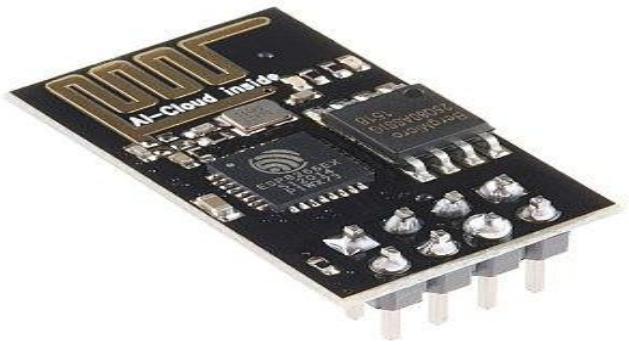


**Fig 3.3: ESP8266 Wi-Fi module.**

**3) pH SENSOR*:*** A change in the pH of water can alter the behavior of other chemicals in the water. For example, ammonia is harmless to fish in water that is acidic. But, as pH increases ammonia becomes toxic. Furthermore, many heavy metals dissolve in acidic water. pH is a measure of how acidic/basic water is. The range goes from 0 - 14, with 7 being neutral. pHs of less than 7 indicate acidity, whereas a pH of greater than 7 indicates a base. pH is really a measure of the relative amount of free hydrogen and hydroxyl ions in the water. Water that has more free hydrogen ions is acidic, whereas water that has more free hydroxyl ions is basic. Since pH can be affected by chemicals in the water, pH is an important indicator of water that is changing chemically.

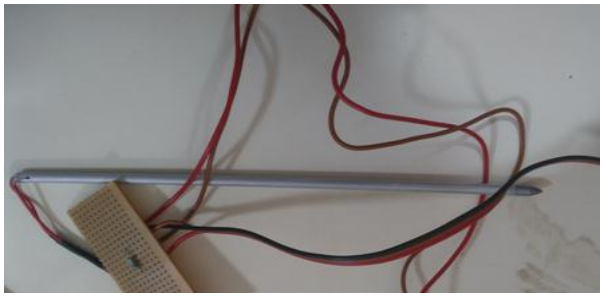

***Fig 3.4 pH sensor***

***4) Turbidity Sensor:*** Turbidity is an indicator often used to find the amount of suspended sediment in water. By cumbersome mechanical sampling, it is possible to measure the concentration of suspended solids (in mg/ l) in water, but turbidity is increasingly used instead, as it is easy to use and cheaper too. High turbidity has a number of detrimental effects on aquatic ecosystems: decrease in light penetration (limiting plant growth), fish movements and the ability of predatory fish and birds to see their prey. High turbidity means high concentration of suspended solids, which can harm fish and other aquatic fauna. These suspended solids in the process of settling down to the ocean bottom have a choking effect on bottom dwelling organisms and aquatic habitats.

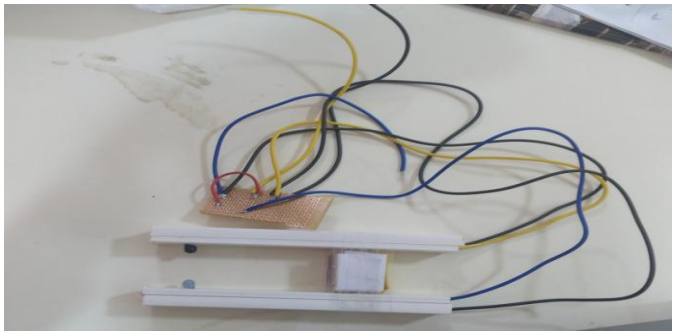

***Fig 3.5: Turbidity sensor***

**5) Temperature Sensor:** The LM35 is one kind of commonly used temperature sensor that can be used to measure temperature with an electrical o/p comparative to the temperature (in °C). It can measure temperature more correctly compare with a thermostat. This sensor generates a high output voltage than thermocouples and may not need that the output voltage is amplified. The LM35 has an output voltage that is proportional to the Celsius temperature. The scale factor is .01V/°C.

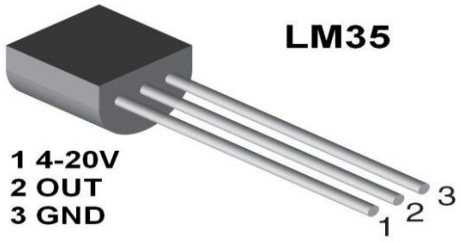


*Fig 3.6 LM35 Temperature Sensor*

## IV.EXPERIMENTAL PROCEDURE

### A. Analysed Information

Aquaculture is increasingly considered as an integral component in the search for global world food security and economic development. The vast majority of aquaculture production takes place in China.

### B. Parameters Description

1) ***pH:*** Changes in the pH, especially sudden changes, can prove harmful or even fatal to fish. As the pH rises, it increases the toxicity of chemicals such as ammonia. pH changes are particularly hard on young and sick fish. In a number of species of fish, breeding occurs only within a specific pH range. Maintaining a pH in the range of 8.1 to 8.4 in marine systems will offer a natural, antiseptic effect, helping fish resist illness and also keep coral from calcifying at accelerated speed. If the pH is in constant fluctuation, or is fixed at a position that is too high or low, it can be harmful to the organisms in your aquarium. The pH should be tested regularly to maintain ideal conditions and also to foresee any dangerous ammonia or nitrate spikes.

2) ***Turbidity:*** Turbidity is caused by suspended or dissolved particles in water that scatter light making the water appear cloudy or murky. Particulate matter can include sediment especially clay and silt, fine organic and inorganic matter, soluble colored organic compounds, algae, and other microscopic organisms. Ability of water to transmit the light that restricts light penetration and limit photosynthesis is termed as turbidity and is the resultant effect of several factors such as suspended clay particles, dispersion of plankton organisms, particulate organic matters and also the pigments caused by the decomposition of organic matter.

3) ***Temperature:*** Temperature is widely known to affect development and metabolic rates in marine fish and is undoubtedly an important environmental component of early and late hatching and subsequent vital rates. It is also defined as the degree of hotness or coldness in the body of a living organism either in water or on land. As fish is a cold blooded animal, its body temperature changes according to that of environment affecting its metabolism and physiology and ultimately affecting the production.

   Higher temperature increases the rate of bio-chemical activity of the micro biota, plant respiratory rate, and so increase in oxygen demand. It further cause decreased solubility of oxygen and also increased level of ammonia in water. However, during under extended ice cover, the gases like hydrogen supplied, carbon dioxide, methane, etc. can build up to dangerously high levels affecting fish health.

### C. Applications

Growing of fish in ponds is known as fish culture. This system provides continuous observation and instant solution to the hitches associated with the fish ponds. It is not always possible for one to continuously monitor and control the quality of water for its purpose. So this proposed method helps in providing a complete solution to develop a remote observing and controlling of water quality parameters in fishpond by sensors via wireless communication in IoT platform. This system can be used in Aquariums, Fish farms, Fishery Companies.

## V.RESULTS AND DISCUSSION

### A. Results

Remote water quality observing system using wireless sensors is developed to assist aquaculture farmers in observing the water quality of their aquatic environment as shown in Fig 5.1.

***Fig 5.1 Prototype of Aquaculture Species***

### Observing System

The aim of this system is to alleviate the problems caused by manual checking such as tedious calorimetric test and exhaustive inspection due to humid and spacious farm. Benefit of using the system includes more efficient checking of the pond since the system would monitor the water quality in a timely manner and alert the farmers upon detecting degradation of the water quality.

***Table 5.1 Data stored in Cloud for pH,Turbidity and Temperature***

| Date & Time | pH | Turbidity | Temperature |
|---|---|---|---|
| 03/04/2019 & 14:04:20 | 1023 | 90 | 216 |
| 03/04/2019 & 14:04:58 | 1023 | 1021 | 216 |
| 03/04/2019 & 14:05:10 | 1023 | 1022 | 216 |
| 03/04/2019 & 14:05:25 | 1023 | 1021 | 216 |
| 03/04/2019 & 14:05:54 | 1022 | 1021 | 214 |
| 03/04/2019 & 14:07:18 | 1023 | 1023 | 213 |
| 03/04/2019 & 14:08:18 | 1023 | 1021 | 216 |
| 03/04/2019 & 14:09:50 | 1023 | 1021 | 216 |
| 03/04/2019 & 14:10:52 | 1023 | 1023 | 216 |
| 03/04/2019 & 14:12:24 | 1023 | 1023 | 216 |
| 03/04/2019 & 14:13:26 | 100 | 1023 | 216 |
| 03/04/2019 & 14:15:38 | 100 | 1023 | 216 |

This system establishes a better, flexible, economical and easily configurable aquatic water quality observing system by the application of internet of things and android platform and their pH, Turbidity and Temperature data stored in the cloud is shown in Table 5.1. By continuouslyobservingand controlling the quality of water, the breeding production and aquatic production can be increased and thereby preventing aquatic species kills. This system is most suitable for aquarium and Mari culture zones.

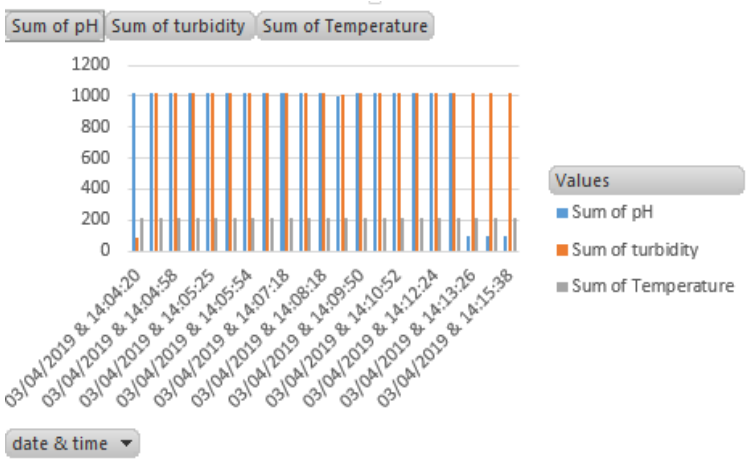


***Fig 5.2Chart of Turbidity, pH and Temperature data***

## B. Discussion

Fish do not like any kind of changes in their environment. Any changes add stress to the fish and the larger and faster the changes, the greater the stress. So the maintenance of all the factors becomes very essential for getting maximum yield in a fish pond. Limited levels of metabolites and other environmental factors affecting fish culture. However, the present chapter would provide the basic guidelines, parameter wise for the fish farmers in obtaining high fish yield in low input via maintaining water quality of their ponds.

Aquaculture produces food fish, sport fish, bait fish, ornamental fish, crustaceans, mollusks, algae, sea vegetables, and fish eggs. Aquaculture is of two types, one is Marine aquaculture refers to the culturing of species that live in the ocean. Another one is Freshwater aquaculture produces species that are native to rivers, lakes, and streams.

Recent analysis of water quality requires a constant observing of the distinctive water quality parameters in the significant catchments. This makes another standard in water quality sensing as the data is to be gathered in the end transferred wirelessly over a certain period of time. Accurate measurement of water quality requires measurement of parameters like pH, turbidity and water temperature level, among others, at different depths on the high spatial determination. Measuring instruments should belong to wireless distributed sensor networks, small, and cheap sensors which would likely be the most ideal choice.

## VI. CONCLUSION

Through software and hardware joint debugging, the results show that the function of pond water quality observing system is implemented, and the real-time observation of important water quality parameters in the process of pond aquaculture is completed, and is of good stability and real-time performance. Wireless technology in internet of thing (IoT) platform is applied in this

system which can realize distributed complex environment monitoring requirements and has a broad market prospects.

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**Conflict of Interest**

The Author declare no conflict of interest