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IoT Based Aquaculture

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Abstract - *Aquaculture, also known as aqua farming, is the farming of aquatic organisms such as fish, crustaceans and crabs by using the various sensors to reduce the risks. Water problem is the major effect for the growth of fish. Monitoring is essential for water quality. This can help to save number of lives.*

The proposed work supports remote monitoring of the fish farming system based on Internet of Things (IOT) for real-time monitor and control of a fish farming system. This will be helpful to be aware of the danger and can take necessary safety measures.

IoT is used in this project helps updating the information about water quality through mail. pH sensor, Water level Indicator, Temperature Sensor & Turbidity sensor is used to measure the water quality level. Esp32 takes the information and sends the information through the mail if the water quality is not in the given thresholds suitable for aquatic organisms.

***Key Words*: Internet of Things (IoT), Aquaculture, Water Quality Monitoring, Raspberry Pi, pH, Temperature, Conductivity, Water Colour, Sensors, Wi-Fi, Internet, Smartphone**

1.INTRODUCTION

With the rapid development of the economy, more and more serious problems of environment arise. Water pollution is one of these problems. In 2014 Hindustan company mercury wastes are dissolved in Kodaikanal Lake due to this effect many lives get into danger. It contaminates the whole water in the lake. So it affects thousands of fishes. It is important to collect this measurement because these factors might affect and be affected by organisms in the pond. Because of continuous monitoring the parameters helps to reduce the problems arrived in future. Research in aquaculture is an input to increase stabilized production. In last decade various scientists have made sustained efforts that resulted in development of modern production technologies that have revolutionized farm production. The main aim of the project is to remote monitoring of the fish farming system by using the various sensors to reduce the risks. In this processes we use sensors like pH value, temperature and level sensors. By using these sensors all the work is automated and it will also be easy to monitor the fish farming remotely from other location. Fish farming have been used for more than three decades. Research in aquaculture is an input to increase and stabilize production.

Fish farming refers to farming variety of marine species such as shellfish, sport fish, bait fish, ornamental fish, crustaceans, mollusks, algae, sea vegetables, and fish eggs to breed, rear and harvest in different water environments such as ponds, rivers, lakes, and ocean. Fish are cold-blooded animals, regulating their body temperature directly by the water environment. Changes in water temperature affect the amount of dissolved oxygen in the water and fish oxygen consumption. Although the fish can withstand a broad water temperature range, any sudden, extreme changes in water temperature will have a considerable impact on fish physiology. A chilling injury will cause the fish to rush into, paralysis with a loss of balance, leading to death. The reason may be the respiratory center, or osmotic regulation is affected at high temperatures. As the water temperature increases the fish suffer respiratory arrest. Fish World magazine found that the amount of dissolved oxygen in water increases or decreases with the seasons. When the water temperature rises, fish metabolic rate will be increased and results in less dissolved oxygen in the water. Low water temperature decreases fish metabolic rate and increases amount of dissolved oxygen in the water. If the amount of dissolved oxygen in water is reduced to below a certain limit fish growth will be hindered. When the amount of dissolved oxygen becomes lower than the fish survival conditions the fish will die.

In general fish farming the acidity and alkaline of the water should be maintained between 6 to 8.Too acidic or alkaline will cause adverse effects, acid erosion of the gill tissue, tissue coagulation necrosis, increased mucus secretion, abdominal congestion and inflammation. If the PH value is less than 4.5, the fish will die. Water quality will directly affect the growth of aquaculture objects which affects the production and economic benefits. In the promotion of health culture concept and environment friendly aquaculture, it has greater demands on water quality management. In the introduction a definition of monitoring suggested that monitoring was for compliance with regulatory standards for protection and safeguarding environmental quality. This is true and forms the basis for monitoring, but other reasons are also important. The aquaculture industry has an important & interest in environmental quality.

As pointed out earlier water quality (in particular) is of essential importance in maintaining the health of the cultured resource. This is true whether the reason be for optimization of fish growth to legal liability in case of litigation due to unacceptable environmental change which affects other resource users Environmental monitoring is therefore an important part of fish farm management.

The continuous and real-time automatic monitoring of water parameters will not only lead to a high quality aquaculture management but also provide accurate experimental data which help to optimize breeding process reduce farming costs and improve breeding efficiency.

Sr.	Parameter	Acceptable range	Desirable range	Stress
1	Temperature (°C)	15-35	20-30	<12, >35
2	pH	7-9.5	6.5-9	<4, >11

TABLE I. RANGES OF THE PARAMETERS

1.2 Literature Review

Pacheco.O [12] fish are cold-blooded animals, regulating their body temperature directly by the water environment. Changes in water temperature affect the amount of dissolved oxygen in the water and fish oxygen consumption. Although the fish can withstand a broad water temperature range, any sudden, extreme changes in water temperature will have a considerable impact on fish physiology. A chilling injury will cause the fish to rush into, paralysis with a loss of balance, leading to death. The reason may be the respiratory center, or osmotic regulation is affected at high temperatures. As the water temperature increases the fish suffer respiratory arrest.

Wen-Tsai Sung [16] found that the amount of dissolved oxygen in water increases/decreases based on seasons. When the amount of dissolved oxygen in water is reduced below certain limit then fish growth will be hindered. When amount of dissolved oxygen becomes lower than the fish survival conditions the fish will die.

P. Bartolome [14] in general fish farming the acidity and alkaline of the water should be maintained between 6 to 8. Too acidic or alkaline will cause adverse effects, acid erosion of the gill tissue, tissue coagulation necrosis, increased mucus secretion, abdominal congestion and inflammation. If the PH value is less than 4.5, the fish will die.

D.YusufMulge [15] temperature sensor are used to deliver the temperature information on a fire extinguishers to website, email-id, and mobile phone number. In this manner, response to fire emergencies is made with in fraction of seconds.

Paraguas M M [11] wireless networks have different security issues in the wireless communication. Wi-Fi Protected Access 2 (WPA2) uses Advanced Encryption Standard (AES) encryption an has more security compared to Wi-Fi Protected Access (WPA).

Jayavardhana G [7] the buzzwords in Information Technology are Internet of Things (IoT). Internet of Things will transform real world objects into intelligent virtual objects. Aim of IoT is to unify world under a common infrastructure, giving control of things around us.

Gigli, M [5] the pH measurement is potentiometric that is, it explains the relationship between the electrode potential and the solution. The meter truthfully responds to the potential, it indirectly and mathematically converts it.

2. Proposed Method & System Architecture

This section comprises of two subsections which are the introduction of required hardware and software technologies and description of the functionality of the architecture.

2.1 Required hardware and software:

1) Sensors: Analog pH Sensor for ESP 32(shown in Fig.1(a)) is used to measure pH of water in this work. This pH sensor is specially intended for ESP 32 and has built-in convenient connection and features. A BNC connector is required to connect the sensor with ESSP 32. The range of this sensor is 0-14 pH. It has an accuracy of ±0.1 pH at a standard temperature of 25ºC and operating temperature range is 0-60°C. Just a few sections of the sensor may be inserted into the water. The reliability of this pH sensor can last for a half year when the water is clean and one month for water with high turbidity [13]. Temperature sensor (DS18B20) connected to the connecting terminal of the terminal sensor adapter with Arduino. This sensor has an accuracy of <±10% F.S and operating temperature range is 5-40°C [14]. We also use Waterproofed DS18B20 Temperature sensor (shown in Fig.1(b)). It has ±0.5°C accuracy from -10°C to +85°C. The upside of this sensor is just required one pin data communication for multiple sensors at once. One Wire Library for ESP 32 is used to measure temperature with this sensor [15].

(a) pH Sensor (b) Temperature Sensor

Fig. 1 Sensors

2) ESP 32: ESP32 is a series of low-cost, low-power system on a chip microcontrollers with integrated Wi-Fi and dual-

mode Bluetooth. The ESP32 series employs a Tensilica Xtensa LX6 microprocessor in both dual-core and single-core variations and includes built-in antenna switches, RF balun, power amplifier, low-noise receive amplifier, filters, and power-management modules. ESP32 is created and developed by Espressif Systems, a Shanghai-based Chinese company, and is manufactured by TSMC using their 40 nm process. It is a successor to the ESP8266 microcontroller.

1.Processors:

   a. CPU: Xtensa dual-core (or single-core) 32-bit LX6 microprocessor, operating at 160 or 240 MHz and performing at up to 600 DMIPS
   b. Ultra low power (ULP) co-processor
2. Memory: 520 KiB SRAM
3. Wireless connectivity:
   a. Wi-Fi: 802.11 b/g/n
   b. Bluetooth: v4.2 BR/EDR and BLE (shares the radio with Wi-Fi)
4. Peripheral interfaces:
   a. 12-bit SAR ADC up to 18 channels
   b. 2 × 8-bit DACs
   c. 10 × touch sensors (capacitive sensing GPIOs)
   d. 4 × SPI
   e. 2 × I^2S interfaces
   f. 2 × I^2C interfaces
   g. 3 × UART
   h. SD/SDIO/CE-ATA/MMC/eMMC host controller
   i. SDIO/SPI slave controller
   j. Ethernet MAC interface with dedicated DMA and IEEE 1588 Precision Time Protocol support
   k. CAN bus 2.0
   l. Infrared remote controller (TX/RX, up to 8 channels)
   m. Motor PWM
   n. LED PWM (up to 16 channels)
   o. Hall effect sensor
   p. Ultra low power analog pre-amplifier
5. Security:
   a. IEEE 802.11 standard security features all supported, including WFA, WPA/WPA2 and WAPI
   b. Secure boot
   c. Flash encryption
   d. 1024-bit OTP, up to 768-bit for customers
   e. Cryptographic hardware acceleration: AES, SHA-2, RSA, elliptic curve cryptography (ECC), random number generator (RNG)
6. Power management:
   a. Internal low-dropout regulator
   b. Individual power domain for RTC
   c. 5μA deep sleep current

Wake up from GPIO interrupt, timer, ADC measurements, capacitive touch sensor interrupt.

Fig. 2 ESP 32

2.2 System architecture

Now we will describe the architecture of our proposed monitoring system. Fig.3 shows the general scheme of our monitoring system.

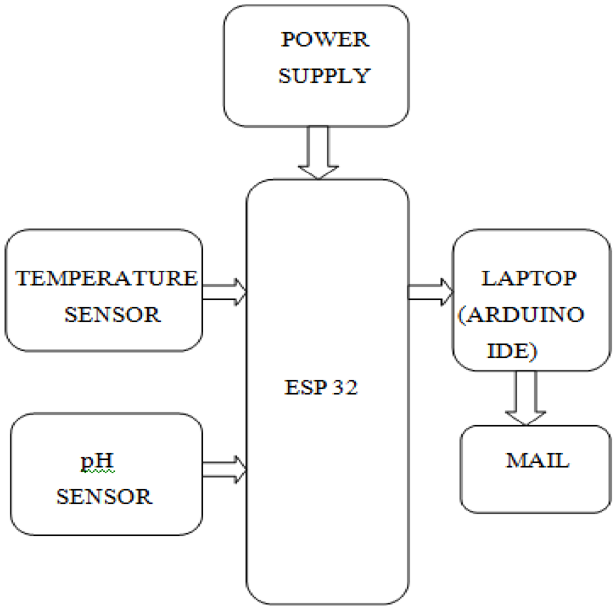


Fig. 3 General scheme of the system

1. **Power Supply Module**

The input to the circuit is applied from the regulated power supply. The a.c. input i.e., 230V from the mains supply is step down by the transformer to 12V and is fed to rectifier. The output obtained from the rectifier is a pulsating d.c voltage. So in order to get a pure d.c voltage, the output voltage from the rectifier is fed to a filter to remove any a.c components present even after rectification. Now, this voltage is given to a voltage regulator to obtain a pure constant dc voltage.

2. **pH Sensor**

pH sensor senses electro-chemical potential between a known liquid inside and outside the glass. Glass bulb allows agile and hydrogen ions to interact with glass and the glass electrode senses electro-chemical potential of hydrogen ions. To complete electrical circuit a reference electrode is needed. A pH sensor not be used in moving liquids of low conductivity.

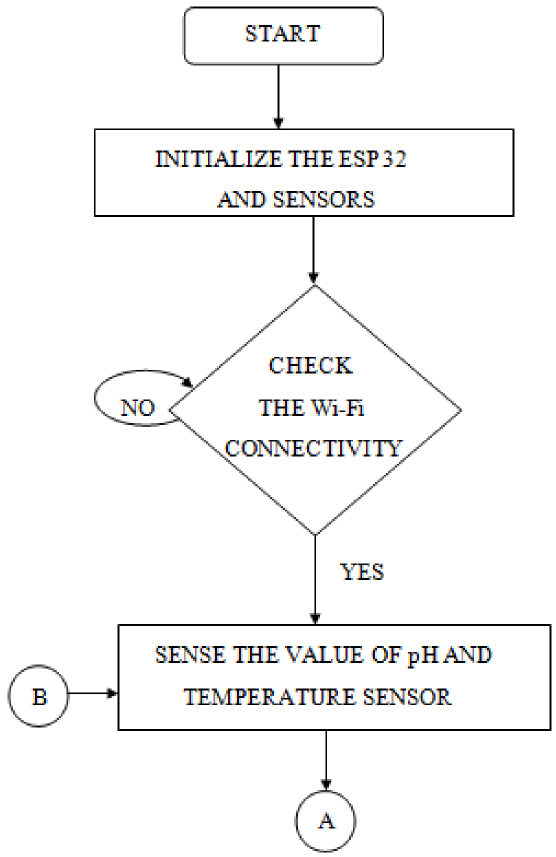
3. **Temperature Sensor**

The DS18B20 temperature sensor is a integrated-circuit, whose output voltage is proportional to Celsius temperature. DS18B20 has advantage over linear temperature sensors because user can obtain convenient Centigrade scaling without subtract a large constant voltage from its output.

4. **Internet of Things**

This is the latest technology to transfer data from source to destination. We are using intra network for demonstration of this project. It is a kind of network of network Technology which is based on information sensing equipment such as Wi-Fi module etc. Cloud computing is a large scale processing unit which processes in run time and it is also a very low cost technology. It is remote server hosted on the internet to store, manage and process data, rather than a local server or a personal computer. The application area of IoT are Home automation, Water quality monitoring, Smart garbage

The ESP 32 also gives a mail if the values are not in the desired range. Mail sending program can be shown in the following flowchart in Fig.4.



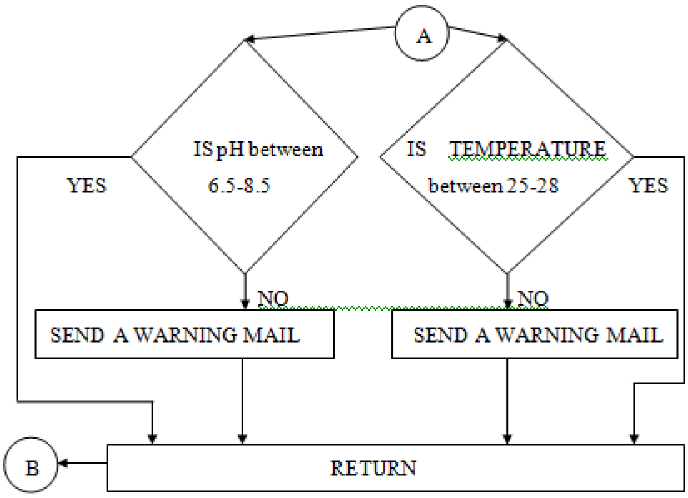


Fig. 4 Flowchart of the mail sending program

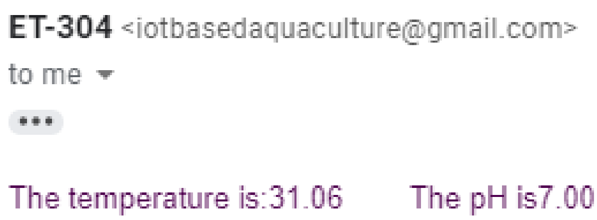


Fig. 5 Screenshot of the mail

2.3 IMPLEMENTATION & RESULT

Our proposed system was implemented in our previously selected pond for some hours. Obtained values are shown in TABLE II.

Time	Temperature (°C)	pH
08:00 am	23.4	8.4
09:00 am	23.9	8.2
10:00 am	24.3	8.5
11:00 am	24.7	8.3
12:00 am	25.3	8.7
01:00 pm	25.7	8.8
02:00 pm	26.3	8.9
03:00 pm	26.1	8.9
04:00 pm	25.9	9.0
05:00 pm	25.6	9.1

TABLE II. OBTAINED VALUES OF IMPLEMENTATION

3. CONCLUSIONS

By successfully completing this project we have concluded that this IoT based Aquaculture can be used for the Aqua farmers in order to get the good output and reduce the risk of the fishes getting killed in large numbers. Also it will save the time of the farmers to do the manual testing of the every factor as they are getting it very easily through this project. This project is reliable, cost efficient and time saving for the Aqua farmers.

Even though this project is helping the aqua farmers for good results there can be always something advancement in the prior technology. The advancement here will be the microcontroller can be replaced with raspberry pi 3 which consists of in built Wi-Fi module and for IoT one can buy website to make it more advanced and secure. Also more sensors can be used to monitor different factors in water like ammonia, Nitrate, Bicarbonates, Salt, etc. The solution can also be automated for every undesired factor. Using this maybe one can get maximum throughput with minimum loss of fishes.

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