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Cost Effective IoT based Automated Fish Farming System with Flood Prediction

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ABSTRACT

The Internet of things (IoT) is a system of interconnected computing devices which can be employed for the automation of assorted systems that are usually handled manually. For the past decades, fish farming has been handled manually using techniques which are not efficient enough in terms of monetary benefits, time consumption and labour. In conventional fish farming, the management of the farm is impossible without the physical presence of the farmer and the chemical changes in the environment cannot be efficiently detected by farmers. In order to overcome the drawbacks of conventional fish farming, we propose an embedded system for automatic control of fish farms. The proposed system supports real-time monitoring and controlling of the fish farm by employing Internet of Things (IoT) and a user-friendly Android application. The proposed system also incorporates an automatic feeding system and an efficient real time water quality management system that monitors the quality of thewater by sensing the physical parameters like pH, temperature, light and water level. Sensors are employed to reduce the human involvement and thereby to reduce the labour cost. The proposed system ensures uniform maintenance of temperature, oxygen, and pH with minimal human involvement by automating recirculation of water. The proposed system also includes a camera module which is deployed in the farm for the live surveillance of the farm via an Android application and a module to notify the farmer of a possible flooding of the farm. The proposed system is aimed at improving the harvest with minimal human involvement reaping greater economic benefits for the farmer.

Key words: Automation, Fish Farming, Internet of Things (IoT), Real Time Monitoring

1. INTRODUCTION

Aquaculture or fish farming is the process of cultivating aquatic species. Generally, there are four steps in the aquaculture production chain. The first step is the hatchery. The breeding of fish, hatching of eggs and rearing of fish through the early life stages happens in the first stage. Once the fishes are matured, they are transferred to the farm, where they can grow till their harvest size. This is the second stage. In the next stage, the fishes are transported to a processing facility, where they are packaged. In the final stage, the fishes are sent to food retailers and grocery stores.

Overfishing in our natural water resources has been increasing every year. Also, since the natural water resources are getting contaminated, the collection from the same is not sufficient enough to meet the needs of the growing population of the nation. Hence, fish farming is the only alternate source of sea food that can solve this issue. Fish farming is important for supplying the future generations with healthy protein options. When compared to chicken, pork and beef, seafood has the highest protein retention and the lowest feed conversion ratio. Conventional fish farming has several drawbacks. Real time monitoring is not possible at all instances. Human involvement is inevitable. Farmers have to rely excessively on manual testing to know the condition of the various parameters of the water. This is inefficient and time consuming and may lead to delay in taking appropriate actions. Conventional fish farming is not able to effectively handle the dynamic changes that the water undergoes. These drawbacks of conventional fish farming can be overcome by automating the fish farming system by employing a combination of IoTand an Android application.

2. LITERATURE REVIEW

Iot based automation of fish farms involves the usage of various sensors and actuators for initiating and performing various actions respectively. A number of IoT based embedded fish farming systems have come before into place integrating a variety of sensors. The fish feeding module is implemented in [3] and [4] and pH control and waste water management in [5]. The proposed system is an embedded fish farming system to include the most commonly used sensors such as temperature, pH, light and water level sensors to reduce the cost of the entire system. The automated fish farming system in [2] uses a number of sensors namely temperature, pH, electrical conductivity and colour sensors which not only makes the system large but also makes it costly. An IoT based automated system is proposed in order to reduce the human labour and difficulty in remote management of the system. The Android app in [2] checks only the water quality but the proposed system can be remotely monitored using an Android app which not only checks the water quality but also enables fish feeding unlike [3] which enables only fish feeding via a website. The fish feeder is self designed in the proposed system. The feeder was designed using PIC micro controller in [4] which enabled the feeding time initially but remote feeding wasn't possible. The idea of the present system was also inspired from [1] wherein a number of sensors were integrated into the system. In [1], the system controls the temperature, turbidity control, light, feeding, dead fish detection and water removal along with live operation of the system. Dead fish detection is not taken into account in this proposed system as the addition of another sensor will make the system complicated. The feeding mechanism is implemented as a separate module. The users can also add any number of ponds to be remotely monitored. In the proposed system, the dirty water will be recirculated using filtering system thereby saving water unlike the removal of water in [1]. By checking the water level using ultrasonic sensor, this system can alert about the occurrence of flood when the level of water rises above the specified threshold. This user friendly system will be cost effective and efficient in flood prone areas like Kerala.

3. OBJECTIVE

The objective of this project is to construct an automated fish farming system that lets the users to remotely monitor and perform necessary actions in the farm without manually doing it. It is an integration which combines all the features necessary to automate the functionalities of aquaculture. It incorporates the basic features available in the existing fish farming systems. Kerala is a flood prone state which adds another difficulty in maintaining a fish farming business in the state. In order to overcome this situation we have incorporated a flood prediction module in the system which alerts the farmer of the rising level of water in the pond. The proposed system also performs the following functions such as temperature control, light control, water level, pH control and automated feeding.

4. PROBLEM DEFINITION

Conventional fish farming involves a high rate of human intervention; it is not efficient enough to dynamically respond to the real-time conditions of the ponds. Since conventional fish farming methods require manual labour at all times, it is not cost effective if considered in large scale. It is also difficult to maintain a fish farm for those who work and cannot monitor the farm constantly. Any undesirable changes in the water quality can highly affect the life of the aquatic animals and thereby affect the production. Keeping these aspects in mind, the proposed system is built to automate the fish farms by implementing IoT thereby increasing efficiency, reducing human labour and making it cost effective at the same time.

5.PROPOSED METHOD & SYSTEM ARCHITECTURE

This section comprises of two subsections in which hardware requirements and software technologies with the description of the functionality in the architecture are considered.

5.1 Required hardware and software

A. Arduino: The sensors are controlled using Arduino UNO[6] which is given in Figure 1. Arduino is an open-source hardware and software company, user community and project that designs and manufactures single-board micro-controllers and kits for building digital devices. Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output (I/O) pins. The micro-controllers can be programmed using C and C++ programming languages.

Figure 1: Arduino UNO

It has 6 analog input pins and 14 digital input/output pins. The operating voltage is 5V and input voltage range is 7-12V. Arduino IDE is required for programming. Arduino Uno should be connected to computer with USB cable to be programmed through USB-to-serial converter.

B. Sensors: Temperature sensor in Figure 2 is a device or a thermocouple which collects the data about temperature from

any source and converts the data into user or device understandable form. Depending upon their range of application, there are various kinds of temperature sensors which have sensing capacity.

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Figure.2 :DS18B20 Temperature sensor

In this work waterproof DS18B20 temperature sensor [7] is used. The DS18B20 is a 1-wire programmable temperature sensor. It is widely used to measure temperature in hard environments like in chemical solutions, mines or soil etc. LDR is used as the light sensor.

The construction of the sensor is rugged and also can be purchased with a waterproof option making the mounting process easy. It can measure a wide range of temperature from -55°C to +125°C with a decent accuracy of 5°C.

In this system, HC-SR04 sensor in Figure 3 which is an ultrasonic sensor[9] is used. At its core, the HC-SR04 Ultrasonic distance sensor consists of two ultrasonic transducers. The one acts as a transmitter which converts electrical signal into 40 KHz ultrasonic sound pulses. The receiver listens for the transmitted pulses and if it receives them it produces an output pulse whose width can be used to determine the distance the pulse travelled. The paper also presents a comprehensive study of flood prediction using this ultrasonic water level sensor.

The pH commonly used for water measurements, is a measure of acidity and alkalinity, or the caustic and base present in a given solution.

In this work, ph-4502c sensor [8] in Figure 4 is used to measure the pH of the water. The heating voltage is 5V ±0.2V (AC / DC) and the working current is 5-10mA. The response time is less than 5s and the settling time being less than 60s. The working temperature: -10-50.

Figure 3: Ultrasonic sensor

Figure 4: pH sensor

C. Automatic Fish Feeder: Automatic fish feeders are electronic devices which are designed to feed the desired fish at regular intervals. These feeders can successfully be used to feed diabetic fish. The automatic fish feeders avoid excess feeding by dispensing the right amount of food, at scheduled times. This automatic fish feeder [10] given in Figure 5 can be remotely controlled by farmers by using various android applications which makes it more efficient and flexible.

Figure.5 Fish Feeder

D. Firebase: Firebase [13] is the cloud platform that is used in this work. It provides a real-time database and back-end as a service. The service provides application developers an API that allows application data to be synchronized across clients and stored on Firebase's cloud.

E. The sensor details are accessed from various[14] sensors which is then stored in these cloud platforms for further accessing and processing. The farmers will be able to provide with appropriate and accurate actions for the farm with these information and analysis C, C++, Java, Android apps etc. are also utilized.

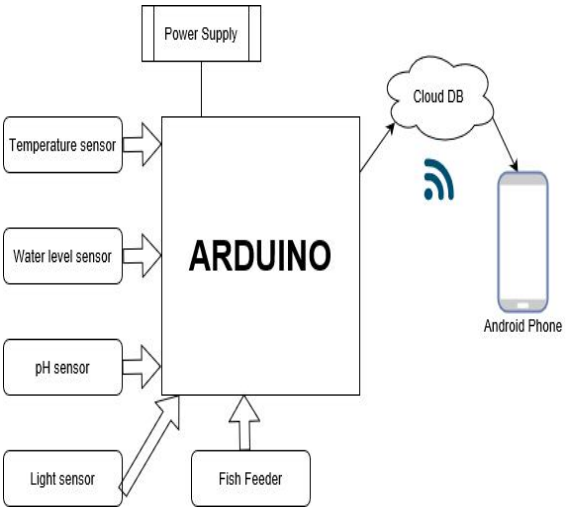
5.2 System architecture

System architecture consist of system components and the subsystems developed that will work together to implement the overall system.

The work for the automated fish farming contains various sensors and their interactions. These sensors are connected to the Arduino for the connection and communication. This system also consists of an Android application for the purpose of remotely accessing the sensor information to perform necessary actions.

We are able to predict the occurrence of flood considering the distance between the water level and the ultrasonic sensor on the farm. This flood prediction is very crucial in areas of heavy rainfall. The threshold value we consider is 25cm for this work. If the threshold given by the user is not satisfied an alert is send to the user's corresponding android application.

Figure 6: General Scheme of the system



Arduino is provided with a constant power supply as shown in the above figure.

The temperature sensor, pH sensor, water level sensor and the light sensor is connected to the Arduino board with the help of wires. The fish feeder is also given to the board for further processing.

Using a Wi-Fi module (esp8266) the information retrieved from various sensors is collected to the cloud database. In this work, firebase is used for the same action.

The acquired data is then viewed by the user through their corresponding android application. Using this application, a user can perform needful tasks for optimal and efficient maintenance of the pond.

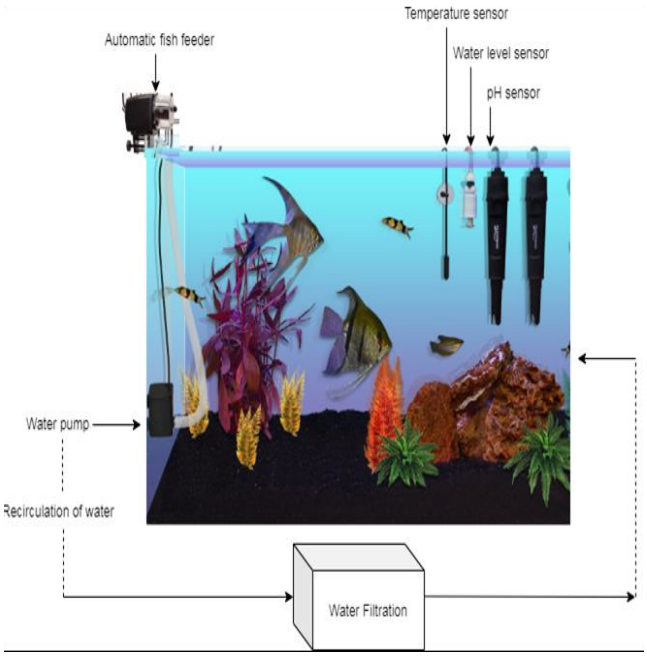


Figure 7: System overview in an aquarium

The system in Figure 7 helps to understand various sensors and their interactions with each other which helps to achieve the automation. If any particular sensor value is not desirable, the farmers can make the needed changes by the method of re-circulation of water and by filtering it on the process. A water pump is used for this purpose of recirculation of water.

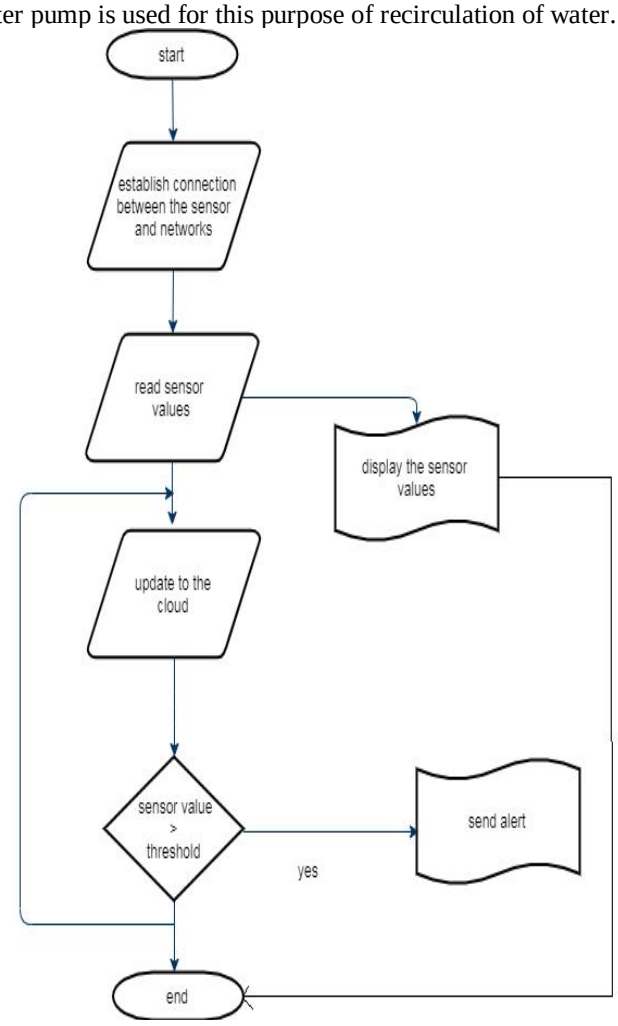


Figure 8: Flowchart of the proposed system

The application indicates if the sensor values indicated by the farmer for optimal maintenance are accurate or not. If found otherwise, the farmer can give specific action to be performed through the provided application. This action can be recirculation of water either to control the water level or to maintain the temperature in the farm. The given program can be shown in the flowchart given in Figure 8.

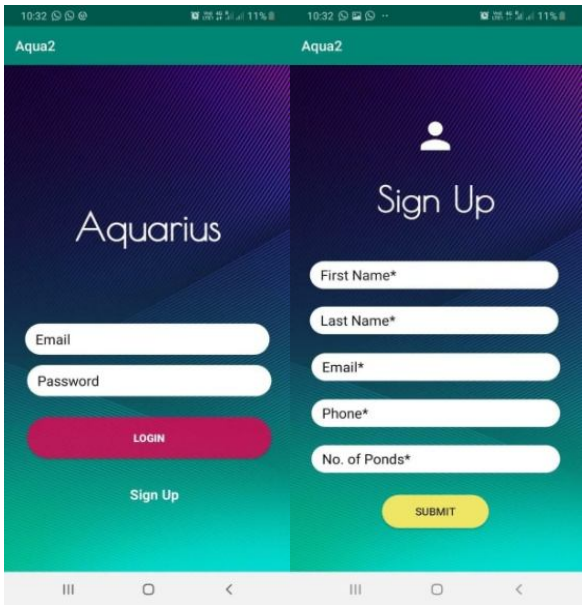


Figure 9 a): Screenshots of the app

An android app named Aquarius was created.This enables farmers to sign up or login and access their farm details. Clicking on the app users will get a screen where they can enter the optimal sensor measurements and feeding requirements. Users can see the current farm environment and give commands according to the well-being of the corresponding fishes.

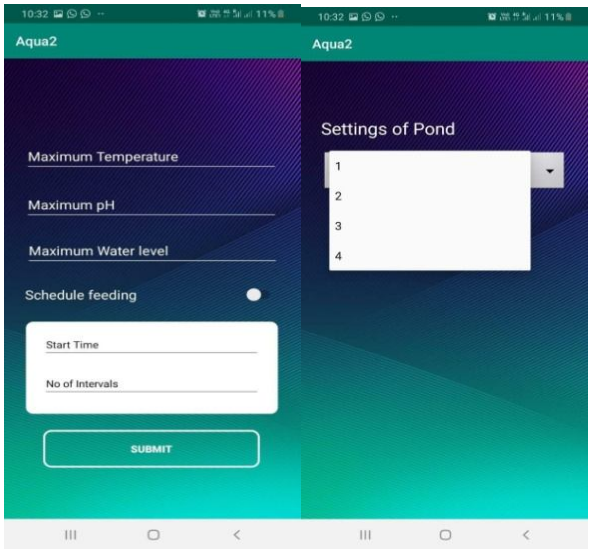


Figure 9 b): Screenshots of the app

A demo automated fish farming system is created using an aquarium which can be controlled through the Aquarius app as shown in Figure 9.

6.IMPLEMENTATION AND RESULTS

The system was set up in an aquarium. In Figure.10 (a), the user registers and then logs in with the login credentials. In Figure.10 (b), the threshold parameters are set. After setting up, the current status of the aquarium can be viewed like in Figure.10 (c). The user can sign out from the profile window given in Figure.10 (d).

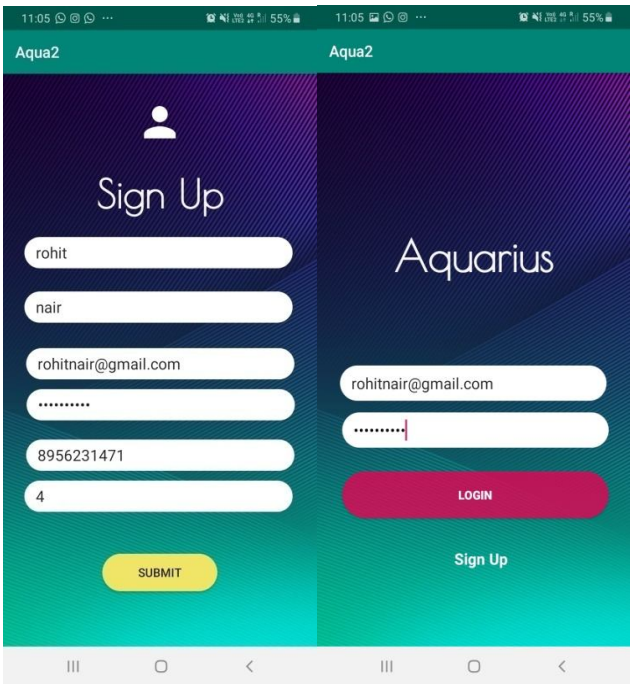


Figure 10 a): Sign up and Login

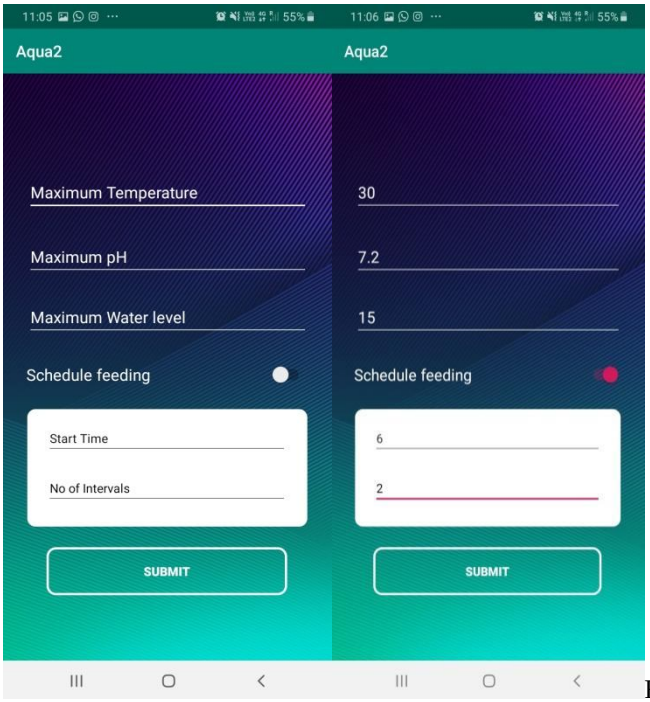


Figure 10 b): Setting parameters

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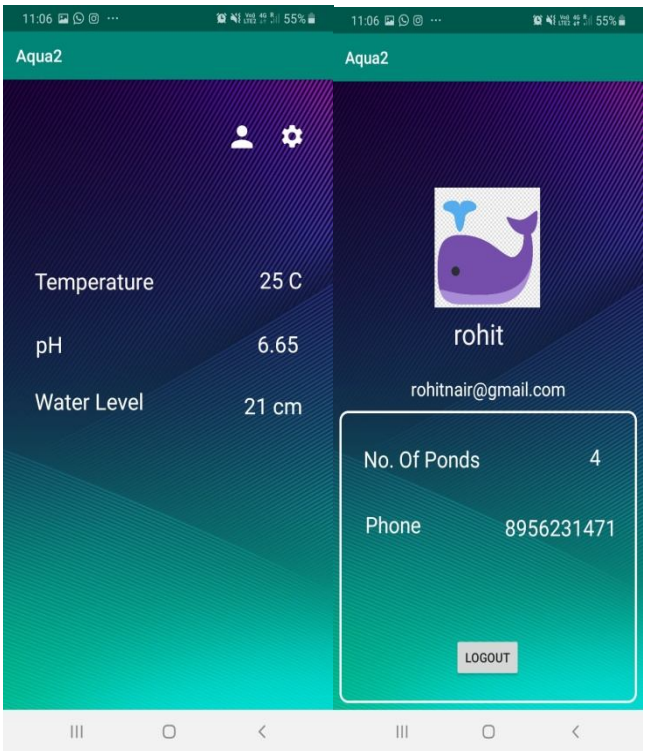

Figure 10 c): Current status **Figure10 d):** Profile

Database: When the user signs up, the details of the user is entered into the online firebase database as shown in Figure 11. Each pond's detail is stored as a separate collection uniquely identified by the Pond ID. The current status is also updated in the database which is then retrieved by the app.

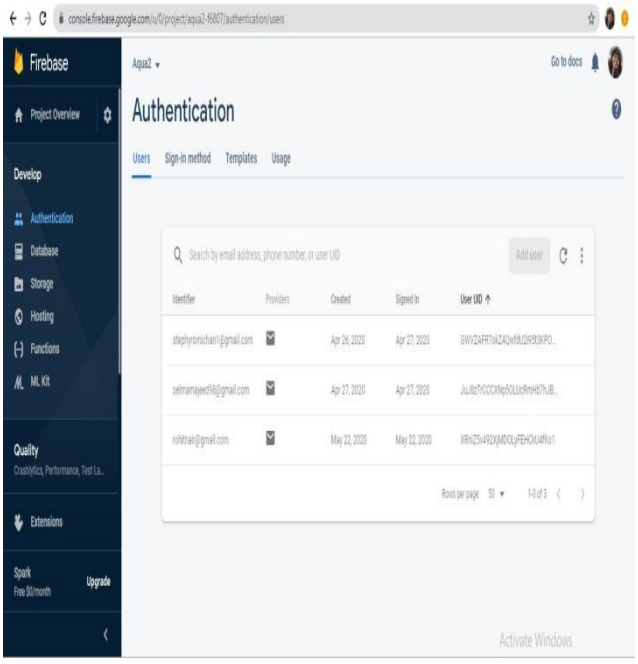

Figure 11 a): Registered users

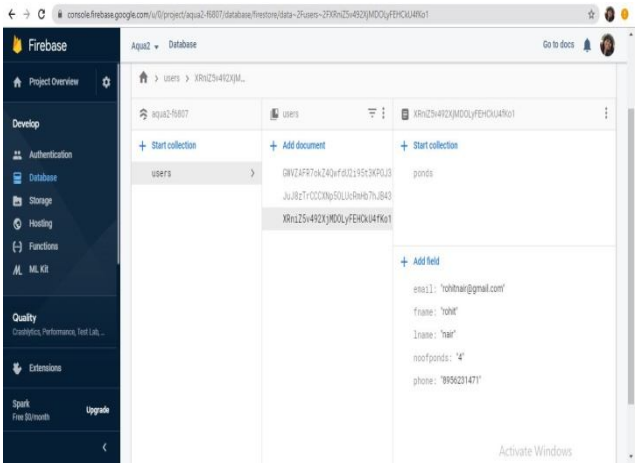

Figure 11 b): User detail

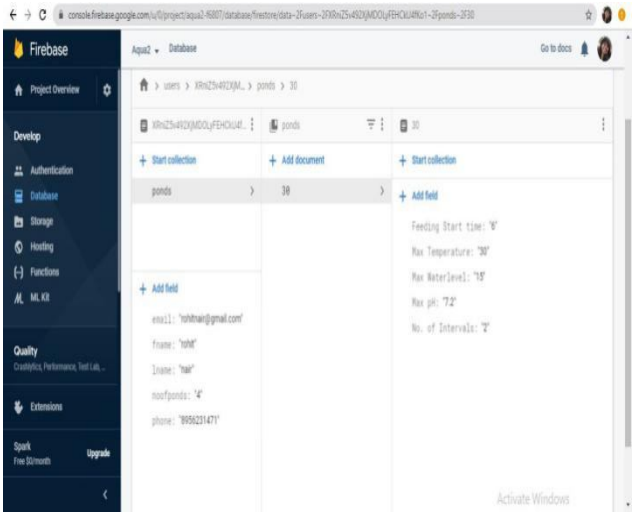

Figure 11 c) : Pond details

7. CONCLUSION AND FUTURE WORK

India is currently at the second position in the world for freshwater fish farmed production. There is extensive scope for its development when improved systems and species are adopted. A large extent of aquaculture in India is still based on traditional farming methods. Converting them to modern farming methods will increase fish production and will also address sustainability of environment. The proposed system is proved to be more economical than the conventional fish farming system in terms of monetary benefits, human involvement and harvest.

The proposed system designs and implements an aquaculture monitoring and controlling system based on IoT. This system gives a better result compared to the other available systems in terms of cost and accuracy. Aqua farmers can avoid the time consuming process of testing the various parameters. This in turn will help to improve the overall efficiency of the farm and

reduces the human labour to a minimum. The unique flooding detection system is especially useful in flood prone areas like Kerala where the farmers will be given timely alerts in order to take precaution against the flooding.

The future work can include more actuators and sensors such as the electrical conductivity sensor, heating rods etc., and features like intrusion detection, dead fish detection and removal, to detect the presence of poisonous substances in the water and to find solutions for the loss of fish due to heavy rains and floods.

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