INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH IN ENGINEERING AND MANAGEMENT (IJSREM)
VOLUME: 07 ISSUE: 05 | MAY - 2023 IMPACT FACTOR: 8.176 ISSN: 2582-3930

Use of IoT in Aquaponics and Aquaculture Systems

1st Hiraj Khawle
Department of Computer Engineering
New Horizon Institute of Technology and Management
(of Mumbai University)
Mumbai, India

2nd Shubham Pawar
Department of Computer Engineering
New Horizon Institute of Technology and Management
(of Mumbai University)
Mumbai, India

3rd Harsh Panchal
Department of Computer Engineering
New Horizon Institute of Technology and Management
(of Mumbai University)
Mumbai, India

4th Dr. Sanjay Sharma
Department of Computer Engineering
New Horizon Institute of Technology and Management
(of Mumbai University)
Mumbai, India

Abstract—This project "Smart Aquaponics" aims to develop a system that would help assist farmers to easily monitor the parameters of the water. Smart Aquaponics is a system developed to make it easier for the people to perform fish farming or pisciculture using Internet of Things (IoT). This system is supported to reduce the hardships faced by the people for managing the pH, temperature and nitrification levels. This project includes a feeding mechanism which will ensure that the fishes are timely fed throughout the day. With the use of a Graphical User Interface (GUI), farmers can also be notified in case any abnormality is detected in the measured values.

Keywords—Aquaponics, Pisciculture, Internet of Things, pH, Nitrification, Graphical User Interface.

I. INTRODUCTION

Aquaculture, a fast growing million dollar industry, relies on manual labour required to test the quality of water which includes testing the pH, nitrification levels, temperature and many other factors. This is either done manually or executed with rigorous chemical testing. This project contains two important concepts – Aquaculture and Aquaponics. Aquaculture is the process of harvesting of fish, shellfish and other organisms in a controlled environment which ensures growth similar to its natural habitat. Aquaponics is a sustainable farming method that combines aquaculture (the raising of aquatic animals such as fish) with hydroponics (the cultivation of plants in water). It involves a closed-loop system where the waste produced by the fish is converted into nutrients for plants to grow, and the plants, in turn, purify the water for the fish. The cycle is continuous and requires no soil, making it a highly efficient and eco-friendly system for growing food. Nitrification is the process used to convert these waste products to beneficiary nutrients. The nitrification process includes converting Ammonia (NH_3) to Nitrite (NO_2-) to Nitrate (NO_3-). Aquaponics is gaining popularity in both small-scale and commercial agriculture as a way to produce food sustainably. The benefits of aquaponics include reduced water usage compared to traditional farming, less dependence on chemical fertilizers and pesticides, and the ability to grow food in a small space. Additionally, the system can be used to produce both fish and plants, providing a diversified source of food.

II. METHODOLOGY

A. Aquaponics System

Aquaponics is a system of aquaculture in which the waste generated by fish or any other aquatic creatures supplies the nutrients for the growth of the plants, which in turn purifies water. An aquaponics system consists of a fish tank, a sediment tank, a Bio-filter and the plant bed. The fishes create a lot of waste materials in the form of Ammonia which in higher quantities is harmful to the fish themselves. The Sediment tank or the radial filter helps reduce the amount of this waste produced. The Bio-filter is a component of an aquaponics system which contains bio media which increases the surface area for necessary useful bacteria to survive. It also allows for the process of Nitrification to begin. Nitrification is the process of biological oxidation of ammonia to nitrite followed by the oxidation of the nitrite to nitrate occurring through separate organisms. These useful bacteria include Nitrosomonas and Nitrobacter. The filtered water is supplied to the plant bed where they utilize the fish waste as a form of a fertilizer. The Nitrification process can be seen in Figure 2.1.

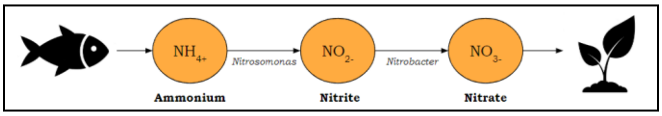

Figure 2.1 – Process of Nitrification

A typical architecture of an aquaponics system looks as shown in Figure 2.2.

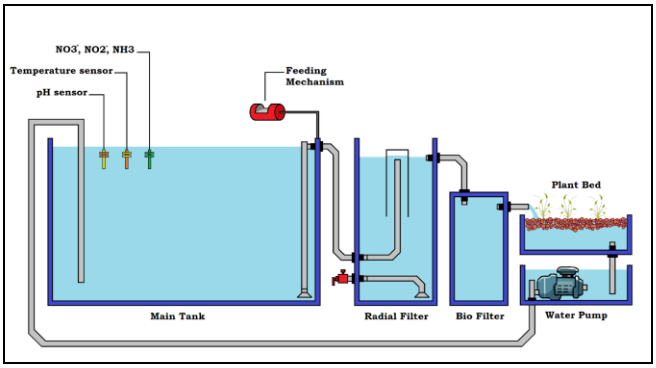

Figure 2.2 – Aquaponics System

B. *Proposed Architecture*

The system architecture designed includes many sensors and actuators to assist with monitoring and deploying of the resources. The microcontroller used is the ESP32 which is used to program the system and to connect the project to the internet where the data is collected in the Google Firebase DB. The Sensors include a Temperature sensor, pH sensor, color sensor and the actuators include a stepper motor and a few peristaltic pumps which help dispense water samples. A relay module is also required to send commands to the motors. The proposed architecture can be seen in Figure 3.1.

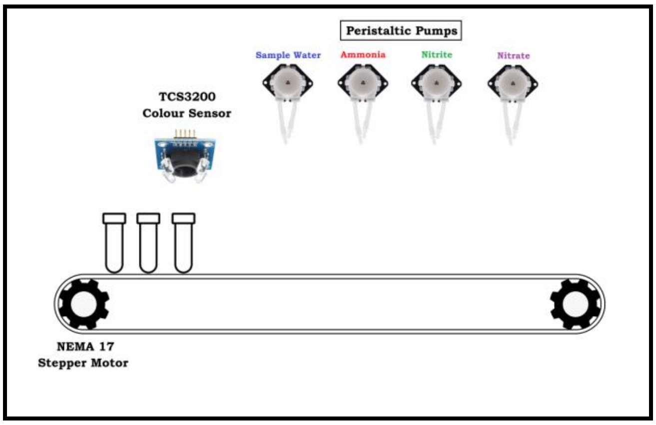

Figure 3.1 – Proposed Architecture

III. SYSTEM IMPLEMENTATION

The various modules used in this project have been listed below along with their illustrations. The features of "Smart Aquaponics system" are as follows:

A. *Temperature Monitoring*

In an ideal aquatic environment, maintaining a proper temperature level of a water tank is crucial as it may affect the survival and growth rate of the fish. Under certain temperature conditions, some fish are unable to reproduce which can directly impact the productivity of the farm. In this project, we have included the DS18B20 Temperature sensor probe to monitor the water temperature of the Water tank. The temperature sensor probe can be seen in Figure 3.2.

Figure 3.2 – Temperature Sensor

B. *pH Sensor*

The pH scale ranges from 0 which is highly acidic to 14 which is highly alkaline. If the pH of water is too high or too low, the aquatic organisms living within it may die. The majority of aquatic creatures prefer a pH range of 6.0-9.0, though some can live in water with pH levels above or below this range. As pH levels move away from this range i.e., up or down, it can survival rates and hatching. Thus, it is important to monitor the pH of the water tank.

C. *Nitrification level monitoring*

In order to measure the levels of ammonia, nitrite and nitrate in water, we can make use of the chemical test kits available. Since, there are no sensors available for measuring the values, we rely on the colour sensor TCS3200 for detecting colour of the sample water mixed with the test kit. For dispensing water and chemical solutions, a peristaltic motor is used which can be seen in Figure 3.3.

Figure 3.3 – Peristaltic pumps

The water is dispensed into measuring flasks and the colour of the liquid is monitored by the sensor TCS3200 as shown in the Figure 3.4.

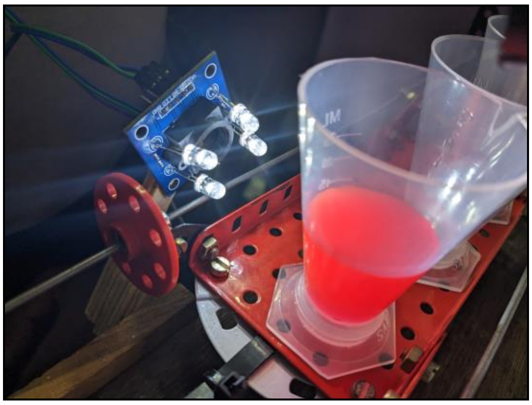

Figure 3.4 – Colour TCS3200 and Measuring flasks

A stepper motor, pulley and timing belt are used to move the measuring flasks under the range of the peristaltic motors. Implementation of the moving mechanism is shown in Figure 3.5 and Figure 3.6.

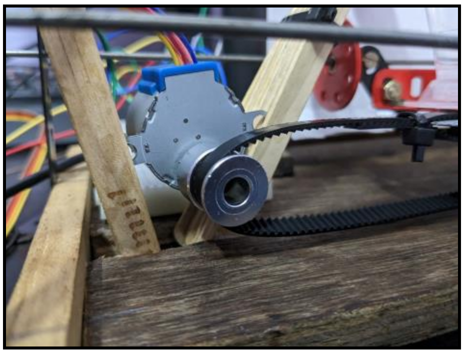

Figure 3.5 – Stepper motor

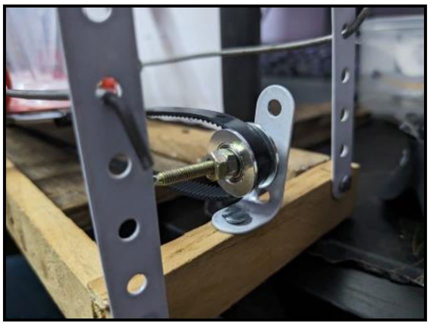

Figure 3.6 – Pulley and belt

IV. RESULTS

After connecting all the modules and programming the ESP 32 board using the Arduino IDE, the final design looks as demonstrated in Figure 4.1. The implemented version includes the temperature sensor DS18B20, Colour Sensor TCS3200, Stepper Motor 28byj-48, ESP32, peristaltic motor, a relay module, breadboard and power supply and the pH sensor probe.

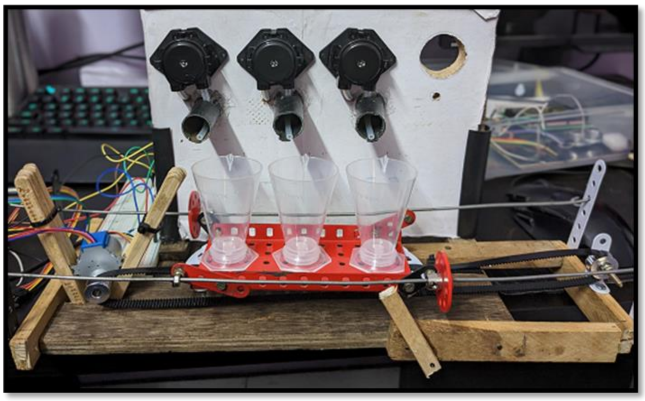

Figure 4.1 – Implemented Design

This project is also connected to an app created using the Android Studio IDE which is used to build Android applications. We have implemented a sign-up and login page for users as shown in Figure 4.2. The user credentials and passwords are collected and stored at the Google Firebase DB database

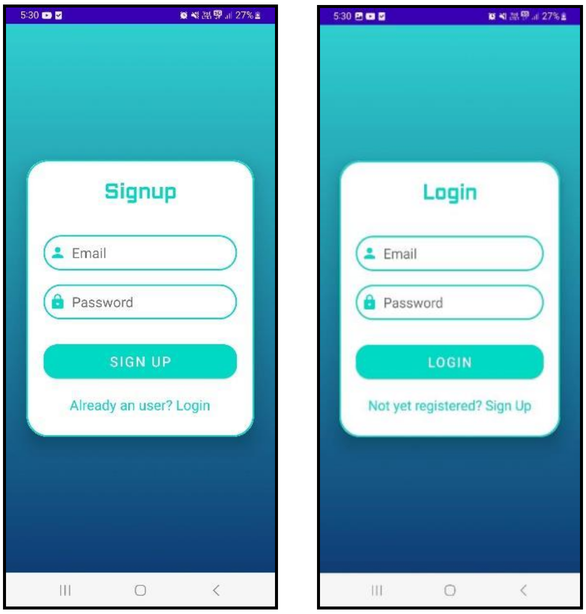

Figure 4.2 – Sign-up and Login page

The values monitored are shown on this app using a simple Graphic User Interface as shown in Figure 4.3.

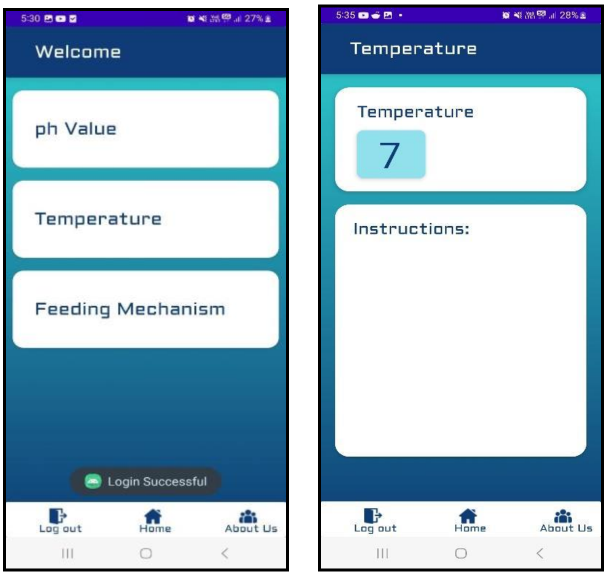

Figure 4.3 – GUI for displaying the monitored values

CONCLUSION

This application and implementation were built due to its ease of access and use. The GUI provides a easy to understand interface where all measured data can be easily monitored. The user can easily take measures if any abnormal values are noticed. Upon noticing a decrease in temperature value, the system can recommend the user to setup a heater to maintain the temperature. Similar recommendations can be given to the user if there is a sudden influx in the values which will help the user.

Further additions to this project could include measuring the level of dissolved oxygen in water and measuring the water turbidity. A system can also be included to ask the user for what species of fish they are going to be farming and adjust the system parameters to that species best possible values to ensure maximum rate of survivability.

Overall, the Smart Aquaponics system can be used by any farmer for fish farming to grow any popularly consumed fish species such as Tilapia, Rohu, Catla, prawns, crabs, etc. Any ornamental fish used for Aquariums can also be farmed using this method.

REFERENCES

[1] Aaron Don M. Africa, Jeremy Czar Christian A. Aguilar, Paulo Arnel A. Pacheco, "Automated Aquaculture System that Regulates Ph., Temperature and Ammonia", published in 2017 IEEE 9th International Conference on Humanoid, Nanotechnology, Information Technology, Communication and Control, Environment and Management (HNICEM).

[2] Sajal Saha, Rakibul Hasan Rajib, Sumaiya Kabir, "IoT Based Automated Fish Farm Aquaculture Monitoring System", published in IEEE Joural of 2018 International Conference on Innovations in Science, Engineering and Technology (ICISET).

[3] Kumar Sai Sankar Javvaji, Md. Abbas Hussain, "Prototype of Aquaculture using IoT Technologies", published in IEEE Journal of 2020 11th International Conference on Computing, Communication and Networking Technologies (ICCCNT).