

Automated Systems for Monitoring in Aquaculture

¹Jayashri Mahadev Swamy, ²Akshata Patil, ³Uday Kiran, ⁴Binal Khalasi ⁵Ganapathi Naik. M

^{1,3,5}Department of Aquaculture, College of Fisheries, Mangalore India

⁴Department of Aquatic Environment Management, College of Fisheries, Mangalore India

²PhD Scholar, Department of Animal Genetics and Breeding, NDRI, Karnal, Haryana

*Corresponding Author: jayashriswamy22@gmail.com

It is an aquaculture-based environment monitoring system that is having a network of wireless sensors that records the environmental stimulus and responds accordingly. This system allows a user with a mobile device to monitor the fish farm Environmental Data with Instant mastery and control over the various environmental data. Temperature, dissolved oxygen, PH value and water level sensing modules are incorporated in this monitoring system and can be known with a span of a click on the device.

As the need for the food is increasing day by day in order to meet the alarming rates of hunger and malnutrition the food sector is also increasing at a rapid pace. Aquaculture is playing a key role in meeting the demands of the on growing malnutrition .As the intensity is increasing day by day there is a need for automated monitoring systems to keep a quick check and alter the system and its parameters automatically.

Benefits of automated farming system

- ✓ Precise adjustments can be made in the environment
- ✓ Improved environmental control
- ✓ Reduced losses caused by major disasters
- ✓ Reduced human interference
- ✓ Quick actions can be taken
- ✓ Improved aquatic product quality.

These following are the components of an automated monitoring system.

Hardware architecture

Hardware architecture is having an integration of sensors which acts as an input device like that of computer and also has controlled devices just like that of the output devices of a computer. These controlled devices work on the commands given by the central processing system after processing the data that is received from the sensors viz., temperature, sensor,

dissolved oxygen, PH sensor and water level sensor. This automated system works on low power supply which can be assisted with the help of batteries, solar panels etc.



Temperature sensing module

Temperature sensing module uses the PT100 sensor. This device is composed of coiled platinum wire, wound onto an insulating cylinder that is a temperature resistancesensor. These sensors receives the change in the temperature and sends the signals to the processor.



Temperature sensing module

(Source: Jui-Ho Chen (2015))

Water level sensing module

The water level sensing module uses an ultrasonic transmitter to transfer acoustic waves that is later received by the receiver. The sound wave reflection time is converted into the water level. The intensity of the transmitted acoustic wave is affected by distance it travels

- ✓ It acts as the echo sounder which is present at the bottom of the vessel
- ✓ If the sound wave reflection time is more then the water level will also be more and vice versa.
- ✓ If the water level is more then the intensity of the waves received by the receiver will also be more.



Water level Sensing Module

(Source: Jui-Ho Chen (2015))

pH and the amount of dissolved oxygen sensing module

After the PH instrument and dissolved oxygen instrument receives the signal from the environment then the signal is sent to the central processing. After processing the value is displayed



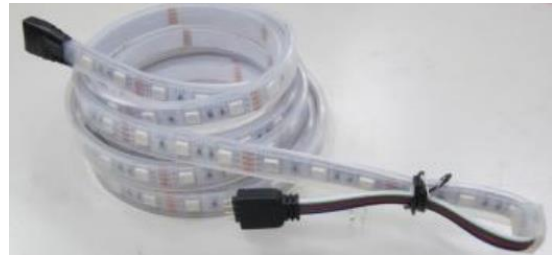
PH meter and DO meter

(Source: Jui-Ho Chen (2015))

RBG light modulating system

The system adjusts the colour of the lights (red blue and green) and adjusts the intensity that is required. Delicate multicolor light is varied to adjust the light color fish need. Generally, this type of lights

is used by the smart aquaponics system where suitable light is provided for plants and fishes.



RBG modulating system (Source: Jui-Ho Chen (2015))

Heaters

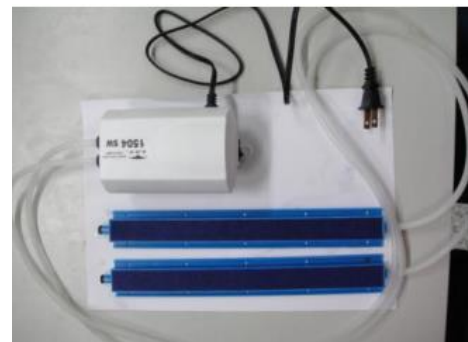
When the temperature is below the range set by the user, the central processing system will automatically send signals to turn on the devise to increase the water temperature by increasing the heating rod load.



Heating rod (Source: Jui-Ho Chen (2015))

Do inflators

When the dissolved oxygen value falls below the range set by the user the central processing system will automatically send a signal to start the load to improve the amount of dissolved oxygen in the water.



Do inflators (Source: Jui-Ho Chen (2015))

Automated fish feeder

The fish feeder can be set through terminal device once the commands given by the mobile the feeder starts releasing the feed. Type of feed depends on the species which we are growing and duration of the feed is adjusted accordingly.



Fish feeder (Source: Jui-Ho Chen (2015))

Software design

The terminal (mobile devices) uses the Android operating system to do the monitoring. The software provides a Windows program design with a graphical user interface tool and program development tools.

The software can be installed in mobile phones and made use with the help of an app

Power supply

This system is designed for low-power sensors. The power supply can be battery-powered or the user can switch to electricity or solar power. The power supply will be used as a stable electricity supply mode with uninterruptible power systems for the auxiliary battery. This greatly reduces the instability caused by power outage or drained batteries increasing the reliability of the entire system

Smart aquaponics system

Aquaponics is the hybrid of aquaculture and Hydroponics where the nutrients from the culturing are utilized by the plants and then the water is pumped back into the system after mechanical, chemical, and biological filtration. Aquaponics is

defined as the process of growing aquatic organisms and plants symbiotically (Yep and Zheng, 2019).

The smart aquaponics system was developed by integrating seven modules:

1. Data acquisition unit,
2. Alarm unit,
3. System rectification unit,
4. Central processing unit,
5. Web application,
6. Mobile application, and
7. Cloud server

Data acquisition unit:

The data acquisition unit continuously collects data using five sensors.

- ✓ Water temperature sensor gathers water temperature of the fish tank.
- ✓ Water flow rate sensor measures water flow rate from the fish tank to plant grow beds.
- ✓ Digital light sensor quantifies light intensity of the environment.
- ✓ pH level sensor detects water pH level in the fish tank.
- ✓ Ultrasonic ranger measures the plant height

Alarm unit

The alarm unit consists of a green LED light, a red LED light, and a buzzer. This unit displays green light when the system is healthy, but displays red light with buzzing sound to alert the user when the system is unhealthy.

System rectification unit

The system rectification unit automatically intervenes and rectifies the system abnormality by activating respective devices. Decision to activate or deactivate the devices is determined by the central processing unit based on the collected data and user preset values. This unit comprises four devices i.e., water heater, water pump, led light, fish feeder.

Central processing unit

It is having the processor which process the data received by the sensors and gives the commands to the system rectification unit. This is having the connection with the terminal devices and can be operated via android platform or through web.

Web application

It also allows the user to timely monitor the aquaponics facilities and remotely controls the devices.

Mobile application

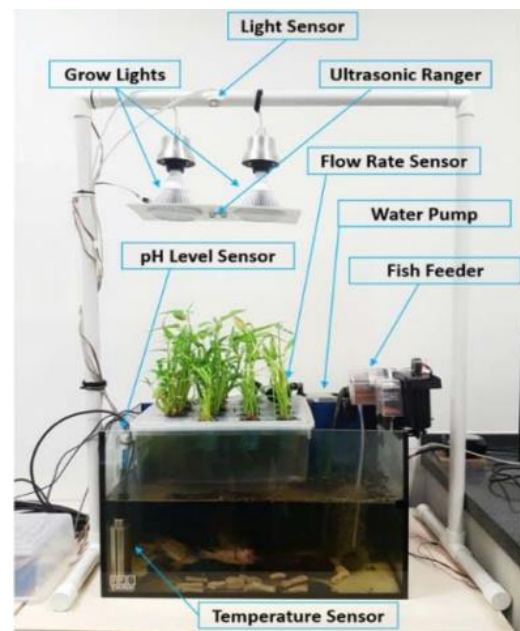
The mobile application was created on Android platform.

Cloud server

The cloud server is used to establish communication between the central processing unit and mobile application.

System implementation

All hardware components were integrated according to the final design diagram. Each component was carefully inspected and tested before the integration. The implemented system was evaluated by simulating different possible scenarios. For example, when the water temperature falls into an unhealthy range, the system should trigger the alarm unit to alert the user, and activate the system rectification unit to rectify the problem by turning on the water heater.



Smart aquaponics system

(Source: Jui-Ho Chen (2015))

Conclusion

Monitoring system is a smart way of monitoring and managing things in the aquaculture production systems. This way of managing the aquatic environment saves time and reduces the man power and increases the efficiency of the system.

Reference

Jui-HO Chen, Wen-Tsai Sung and Guo-Yan Lin (2015). Automated Monitoring Systems for the Fish Farm Aquaculture Environment, 2015 IEEE International Conference on Systems, Man and Cybernetics.

* * * * *