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Abstract

Monitoring of indicators in fish farming is an essential factor for profitable production, the more intense the production system is, the more important monitoring becomes. In the methodology, a bibliographic research was performed and an exploratory research was used to implement a prototype using arduino and monitoring sensors. The goal was to develop a system that assists the management of fish farms, ensuring the accuracy of monitored data, the quality of production and cost savings for the fish farmer. The project has a low implementation cost, provides more convenience in the management of fish ponds and contributes to the reduction of inputs during production, generating a greater profit for the fish farmer.

Keywords: Monitoring; Real time; Arduino; Sensors.

1. Introduction

In 2018, according to the Brazilian fish farming association [1], 722,560 tons were reached, with revenues of around 5.6 billion. Brazil is the fourth largest world producer of tilapia, a species that represents 55.4% of the country's production. Native fish led by Tambaqui, participate with 39.8% and other species with 4.6%.

In fish farming there are four types of farming systems: extensive, semi intensive, intensive and super intensive. The extensive is the system used by small producers, in most cases it is intended for family food or for recreational purposes. In the semi-intensive nurseries and bushes are used, but there is a supply of food for the fish, which consists of balanced feed and live food. The intensive feature is the use of small tanks with high stocking density and high water renewal, is used in high productivity, and aerators are used to keep oxygen levels stable at night due to lack of photosynthesis generated by algae. Already in the super intensive concrete tanks are used, concrete tanks with greenhouse, among others and has the highest productivity of the four systems. Fish are fed balanced diets and aerators are turned on 24 hours a day to maintain water oxygenation. In northern Brazil, the most used system is the intensive one.

Operating cost includes travel to nurseries to periodically measure all biological, physical and chemical indicators. There are also time outlays due to the need to measure the levels of all nurseries. Inaccurate parameter measurements or periodic measurement failures that lead to loss of production, excessive or insufficient use of resources such as food, energy used by aerators, substances to control chemical indicators.

With scenario exposure is ideal to develop metrics as an alternative to control the process of fish breeding and monitoring, and can apply automation for handling reduction and application for monitoring and prevention of ponds assisting in cost management, as the result of monitoring would help in taking decision

2. Materials and methods

In the first phase, a market price and quality study was done to find out which components would best fit the project. Are they:

The Arduino pH Sensor (Figure 1), model PH-4502C, is a practical sensor specially designed to work in conjunction with microcontrollers.

Figure 1: PH-4502C Arduino pH Sensor

Source: Authors (2019).

The DS18B20 temperature sensor (Figure 2) with 9 to 12 bit programmable digital output.

Figure 2: DS18B20 Temperature Sensor.
Source: Authors (2019).

The turbidity sensor (Figure 3), model LGZD Sensor V1.1, is an electronic monitoring module specially developed to work with Arduino microcontroller platforms.

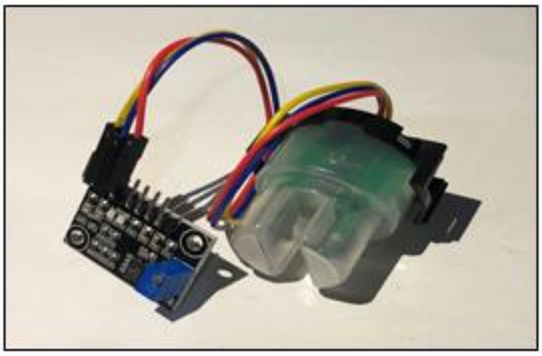

Figure 3: Arduino Turbidity Sensor LGZD Sensor V1.1
Source: Authors (2019).

Figure 4: Arduino UNO board.
Source: Authors (2019).

The UNO arduino board (Figure 4) uses a 5 volt power supply, but is acceptable in the range of 7 volts to 12 volts, the power connector will correct to 5 volts when connected to the board. It has six-pin analog inputs from A0 to A5 that can be used to control the voltage being applied to the sensor pin. There are also 0 to 13 pin digital connections with inputs and outputs, these connections can provide 40 mA with 5 volts.

all of this being controlled by a microcontroller, the ATmega 328, which will be the brain of arduino. For storage of embedded codes EEPROM flash memory is used and non-volatile [10].

Shield W5100 Ethernet Card (Figure 5) allows the arduino to communicate to a local network or internet using the RJ45 network cable [10].

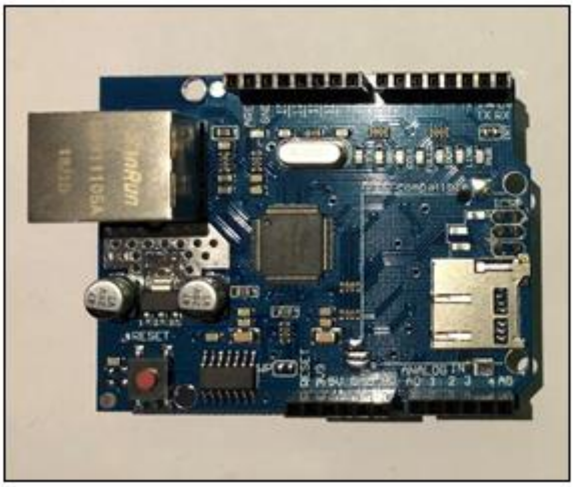

Figure 5: Shield W5100 Ethernet card.
Source: Authors (2019).

Through a bibliographic search, all the information referring to the production and monitoring systems used and the problems that are inserted in them were gathered. The research used is classified as exploratory, researched references in articles and websites such as the Brazilian Fish Association [1] and was also made a visit to the INPA Aquaculture Center, where several production scenarios were exposed and through them it was possible to collect information on types of production systems and the most farmed fish species in the region, the market, advantages and disadvantages of these systems, and the difficulty of obtaining real-time information on monitored parameters.

3. Development

3.1. Theoretical Referential

3.1.1. Aquaculture Production

In the production processes in psychology, constant monitoring of the environment is necessary, so that there is no damage to production due to significant changes in water quality parameters. Should any variation in water quality occur, rapid action must be taken to restore the environment to a prosperous condition for production. Currently, the measurements of the psychoanalysis sites are made only where they are located, the person in charge needs to regularly measure the main water quality parameters using chemical analysis sensors.

By developing in the aquatic environment, aquaculture can be considered one of the most complex productive activities in interactions between the physical, chemical, biological and climate [2].

Water quality is of utmost importance and it should be considered that temperature, turbidity and pH level, among other factors, are very important for rich production.

Temperature is one of the most important features of the aquatic environment. It characterizes much of the other physical parameters of water such as density, viscosity, vapor pressure and solubility of dissolved gases. In addition to influencing factors such as decreased oxygen solubility. Temperature is one of the factors that directly influence the existence of aquatic organisms and species such as bacteria, fish, algae and aquatic plants [5].

PH is the negative logarithm of hydrogen ion concentration expressed in moles per liter, pH equation:

$$pH = \frac{log1}{[H]} \quad \text{(eq 1)}$$

Its value varies between 0 and 14. Being pH less than 7 called acid, above 7 alkaline and when it is 7 is called neutral. This parameter is vital because the pH level indicates whether water has a toxic effect on fish being farmed [5].

Determining water turbidity is important because turbid waters are not considered good for fish farming as it prevents sunlight penetration, hindering phytoplankton development and photosynthesis that generates the main source of oxygen in the aquatic environment.

3.1.2 Technologies

The use of technologies in fish farming helps to reduce costs as they provide a better use of the chemical conditions of the environment, prevent loss of production due to human failures such as not measuring the indicators for any reasons, erroneous measurements, omission of problems in the owner's environment.

The evolution of technology has made it very easy to access the internet, there are many ways to access it from smartphones, tablets, notebooks, desktops and other devices that can connect to the network. This flexibility has shown how powerful web development has become. today [6].

In view of this thinking, the following technologies were used in the project in order to create software to increase the practicality of fish management.

HTML (Hypertext Markup Language), in Portuguese, markup language, is translated by browsers for website creation for the purpose of visual or behavioral characteristics [8].

Sascading Style Sheets (CSS) works in conjunction with the browser to enhance html by improving its appearance. With changes in titles, definition of images, creation of tables, borders among others [7].

To be able to access HTML pages it is necessary to use Transmission Control Protocol (TCP) and Internet Protocol (IP) in order for computers to communicate from the host that is located on the web page to the requestor. [9]

The arduino is a computer that can hold programming codes for processing inputs and outputs between it, and can have external components attached to the arduino, such as temperature sensors, LEDs or any other controllable component, and there is possibility of communication to a computer or network to exchange data collected by sensors on the web page [10].

For the creation of the codes we used the Integrated Development Environment (IDE), Arduino Software, based on the C ++ programming language [10].

The system, in short, uses sensors to monitor the indicators and sends the data to the arduino board which is responsible for sending the data to web application where the owner and owner can have access to all information in real time.

3.2. Results

Development has been divided into three phases.

The first phase comprised the choice of items needed for the project. In the bibliographic study, the types of production systems, the indicators monitored during each production and the Arduino platform for electronic hardware prototyping were studied. It was also defined which sensors would be used in the project, considering the accuracy of the measurements and costs.

3.2.1 Software Development

The second phase was the application of the Arduino platform with the Uno board with pH, temperature and turbidity sensors that will measure water quality, coupled with the SHIELD board that communicates via the network using the TCP / IP protocol for access to information. collected by the sensors installed on the arduino. It will be controlled through the Arduino-hosted C ++ programming language. For monitoring we used web pages containing the markup language HTML and CSS (Figure 5).

```
client.println("<title>Dash</title>");
client.println("</head>");
client.println("<body bgcolor='#000000'>");
client.println("<div class='linha'><div class='titulo'>Piscina 1</div>");
client.println("<div class='box'>");
client.println("<div class='titulo'>Temperatura</div>");
temperatura(client);
client.println("</div>");
client.println("<div class='box'>");
client.println("<div class='titulo'>Turbidez</div>");
turbidez(client);
client.println("</div>");
client.println("<div class='box'>");
client.println("<div class='titulo'>pH</div>");
ph(client);
client.println("</div>");
client.println("</body>");
client.println("</html>");
```

Figure 5 - Software Development
Source: Authors (2019).

Figure 6 - Web Application
Source: Authors (2019).

3.2.2 Structure Development

The third phase consisted of incorporating the sensors and the arduino board, where the sensors will be responsible for capturing the input data (pH level that will indicate if the water is acidic, neutral or alkaline, temperature level in degrees celsius and quality). the arduino board will be responsible for managing the collected data and hosting the HTML page where the parameter information will be made available. During this phase, prototype tests were performed

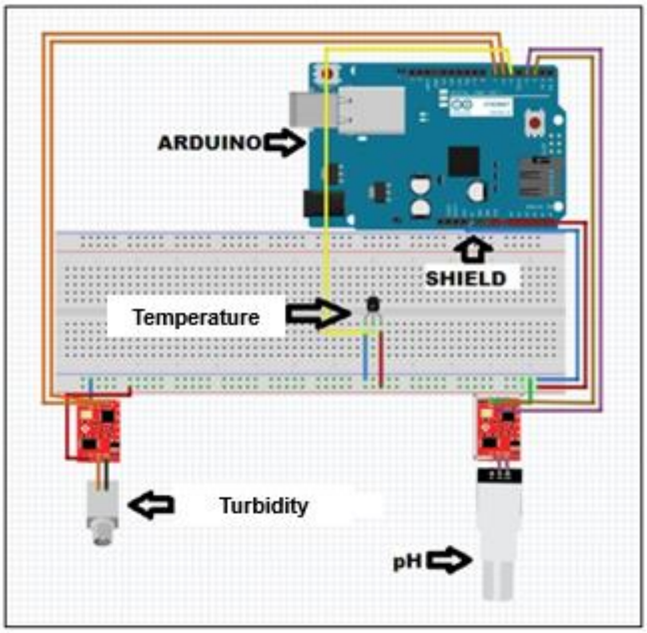

Figure 7 - Interconnected Components
Source: Authors (2019).

Each species has a temperature at which it best adapts and develops, this temperature being called the optimal temperature. Fish metabolism is increased as temperature increases. Tropical fish generally live well at temperatures between 20 ° C and 28 ° C and their maximum appetite is between 24 ° C and 28 ° C [2] [4].
The temperature sensor works through a one-wire bus that communicates between the microcontroller and the sensor, from which its power can be derived. It can operate from -55 ° C to 125 ° C.
The pH indices, in turn, are influenced by respiration, photosynthesis, fertilization, liming and pollution, making the water alkaline, neutral or acidic. The desired concentration range is between 6 and 9. The arduino PH sensor is made up of a PH electrode and an electronic module that mediates the arduino, so that the electrode can be submerged in water with only the exposed external cable.

Table 1: Description of stress and mortality rates of P.H

PH LEVEL				
Lethal	Increased Stress	Desirable Range	Increased Stress	Lethal
0 to 3,9	4 to 5,9	6 to 9	9,1 to 10,9	11 to 14

Source: Authors (2019)

Regarding turbidity, the use of turbid waters in fish farming is contraindicated, as it prevents the penetration of sunlight and consequently impairs the development of phytoplankton.
The green color of the water is the most suitable for fish breeding, as it demonstrates maintenance of aquatic life. Bluish or greenish blue also indicates good productivity.
The Arduino turbidity sensor emits infrared light at its end and is capable of detecting particles that are

suspended in water.

The testing phase was carried out using a fish tank provided by the National Institute of Amazonian Research (INPA) and proceeded as follows.

Data readings are taken in real time by the sensors and sent to the web application for authentication of the information on the screen of the device used. Hot and cold water was then used to assess the temperature change. At pH, hydrochloric acid and soda ash (sodium carbonate) were used to decrease and increase the pH level, respectively. The turbidity sensor was tested using a turbid water tank and a water tank under ideal production conditions and comparing the information shown on the screen.

The sensors noticed the parameter changes and showed the information correctly in the web application.

3.2.3 Discussion

The project is feasible to use in fish ponds due to safety, practicality in management and low cost of components.

Through the use of sensors, the prototype becomes a very important application as it contributes by increasing the production level and decreasing the fish mortality rate. From an administrative point of view, it contributes to reducing the waste of inputs, generating a higher profit. In addition to facilitating management, as the farmer will have all the necessary information of the parameters through monitoring generated by the prototype on the screen of your mobile or computer

4. Conclusion

In the research we concluded that the types of production systems used in fish farming use techniques that require the maximum dedication of the fish farmer to avoid irreparable losses in production and development, they require constant monitoring of water quality, today requiring displacement to the fish. collection of monitored data mainly in nurseries and captivity, where sudden changes in water temperature occur.

The development proved the relevance of this tool in the daily production, because it directly assists the fish farmer in the management of the nurseries, continuously controlling the pH, temperature and turbidity level thus providing greater practicality in the management of fish ponds, higher quality of the fish. water and more quality in production.

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