Application of automation with Arduino ONE in a rustic pond aquaculture farm, to increase productivity

Aplicación de la automatización con Arduino UNO en una granja acuícola de estanque rustico, para incrementar la productividad

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Abstract

This project has the goal of monitoring the Mechatronic Design process carried out for the implementation of an automated monitoring and control system of the necessary physical-chemical conditions that must be considered in a rustic pond dedicated to the production and breeding of tilapia; with the purpose of optimizing fish production in Jalpa de Méndez, Tabasco. Through a mechatronic system based on ARDUINO UNO consisting of: control, actuation and sensing system that achieves intelligent decisions to problems in branches of the rural aquaculture sector that do not have equipment for the development of automated products.

Control Arduino, Aquaculture

Resumen

Este proyecto tiene como meta el seguimiento al proceso de Diseño Mecatrónico realizado para la implementación de un sistema automatizado de monitoreo y control de las condiciones físico-químicas necesarias que se deben de considerar en un estanque rustico dedicado a la producción y cría de tilapia; con el propósito de optimizar la producción piscícola en Jalpa de Méndez, Tabasco. A través de un sistema mecatrónico basado en ARDUINO UNO constituido por: sistema de control, actuadores y sensores que logre decisiones inteligentes a problemas en ramas del sector rural acuícola que no dispone de equipos para el desarrollo de productos automatizados

Control, Arduino, Acuacultura

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Introduction

Aquaculture plays a crucial role in global food security, and tilapia farming has gained prominence due to its high growth rate and adaptability. This article explores the automation of tilapia farms in rustic ponds as an innovative strategy to improve efficiency and sustainability in tilapia production. It discusses the technologies involved, the benefits obtained and the implications for the future of sustainable aquaculture.

Fisheries and the development of the fish farming sector is currently one of the fastest growing industries in recent decades around the world, with per capita consumption of combined fish products at levels of 15.8 kilos per year.

In recent years, however, it is also one of the most threatened sectors, not only because overfishing is exceeding the limits of sustainability, i.e. it is taking place at a faster rate than replenishment, but also because several fish species are being depleted. The above situation, added to the alarming realities of human overpopulation, soil desertification, freshwater scarcity and environmental pollution, are the consequences of accelerated environmental degradation worldwide, and therefore man is obliged to come up with solutions for the protection of ecosystems.

Tilapia farming in rustic ponds has been a common practice in regions with limited resources. However, environmental challenges and the need to increase efficiency have led to the development of automation systems. This article examines how automation improves farming conditions and optimises available resources in rustic ponds.

Tilapia is a freshwater fish species that has become one of the most popular for aquaculture. Its fast growth, disease resistance and low production cost make it an attractive option for small-scale farmers.

Arduino UNO automation of a tilapia farm can help improve efficiency and productivity. Automated systems can monitor and control water parameters, feed the fish and perform maintenance tasks regularly and efficiently.

In a rustic pond, automation can be a challenge. Rustic ponds are often smaller in size and have less infrastructure than commercial ponds. However, there are some solutions that can help automate a tilapia farm in a rustic pond.

Methodology to be developed

Figure no. 1 shows the methodology used, starting with the characterisation of the study area, where a reconnaissance of the work areas will be carried out to identify the conditions in which the current state of the aquaculture farms is, to determine the operation and functioning of the same, to obtain a diagnosis, after the characterisation, we will continue with the consultation of different information providers, to identify the current technologies for the monitoring and control of the physicochemical elements that should be considered in the farm, making a comparative table where the characteristics, advantages and disadvantages and costs of each one of them are observed,

Then, an analysis of the control logic, system architecture design, system development and implementation of the system for interaction with the different parameters to be monitored will be carried out, and finally, the system functionality tests will be carried out, the results obtained will be evaluated and suggestions for improvement will be made.
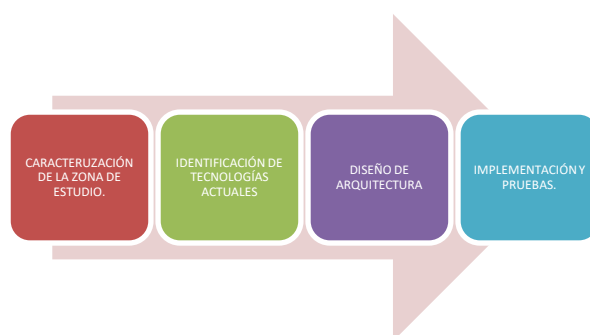
Figure 1 Diagram representing the methodology applied
Source: Own elaboration

Development

In order to carry out this project, several aspects are evaluated, such as the following:

Water quality control systems

Water quality monitoring systems are essential to keep fish healthy. These systems can monitor oxygen levels, pH, temperature and other water parameters.

Water quality monitoring systems are available that are relatively affordable and easy to install. These systems can use sensors to collect data and send it to a controller. The controller can use this data to trigger devices that adjust water quality.

Automatic feeding systems

Automatic feeding systems can help ensure that fish receive the right amount of feed in a timely manner. These systems can use sensors to detect the presence of fish and dispense feed automatically.

There are automatic feeding systems that are suitable for small ponds. These systems typically use a timer to dispense feed at regular intervals.

Maintenance systems

Maintenance systems can help to carry out regular maintenance tasks. These systems can be used to clean ponds, change water and perform other work.

There are maintenance systems that are suitable for small ponds. These systems often use motors and pumps to perform maintenance tasks.

Benefits of automation

Automation of a tilapia farm can offer a number of benefits, including:
Improved efficiency

Automated systems can help reduce the time and effort required to manage a tilapia farm.

Increased productivity

Automated systems can help improve fish growth and survival.

Reduced costs: Automated systems can help reduce production costs.

Automation Technologies:

Water Quality Monitoring.

Advanced sensors constantly monitor parameters such as temperature, pH and dissolved oxygen levels. Automated systems adjust these parameters to maintain an optimal environment for tilapia growth as shown in the table below

Parameter	Optimum range
Oxygen	>4.0mg/L
PH	6.0mg/l – 9.0mg/l
Temperature	27° C - 30° C
Nitrite	< 0.25 ppm

Table 1 Parameters to be monitored
Source: Own elaboration

Automated Feeding

Automated feeding systems dispense feed at specific times and in precise amounts, minimising wastage and optimising feed conversion rate.

Health Monitoring

Underwater cameras and health sensors monitor the behaviour and physical condition of the fish. Early detection of diseases enables fast and effective interventions.
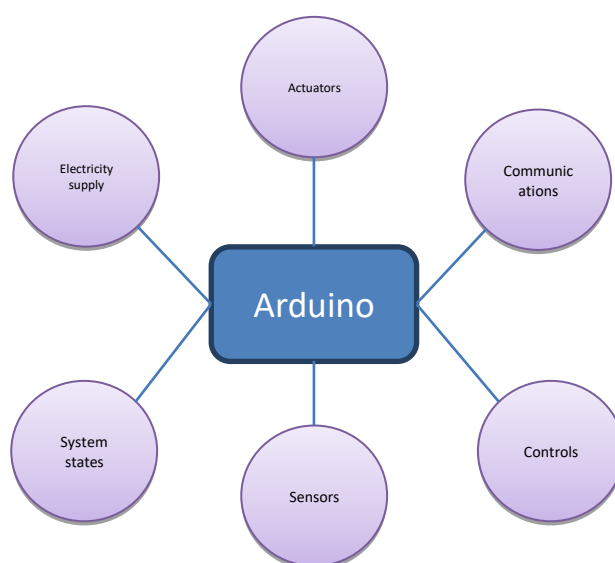
Benefits and challenges

Benefits

  - Increased production efficiency.
  - Reduced use of resources such as feed and water.
  - Improved fish health and growth.
  - Reduced long-term operating costs.

Challenges

  - Initial cost of implementation.
  - Technical maintenance and staff training.
  - Adaptation to specific farm conditions.

Figure 2 Structure of the system
Source: Own elaboration

Results

Technology transfer was achieved with the implementation of this project.

Technical assistance is provided for the implementation of the system.

The system will undoubtedly lead to a reduction of maintenance and maintenance costs of the ponds.

The optimisation of resources leads to savings in basic raw materials, time and effort.

Therefore, this system will increase tilapia production significantly.

Acknowledgement

Conclusions

The automation of tilapia farms in rustic ponds represents a significant advance in sustainable aquaculture. Despite the challenges, the long-term benefits in terms of efficiency and sustainability are evident. Continued research in automation technologies, together with appropriate training for farmers, will continue to drive the development of this technique.

Collaboration between scientists, engineers and farmers is essential to maximise the potential of automation in aquaculture and to ensure a stable and sustainable supply of tilapia for future generations.

Tilapia production is significantly increased by applying an automated system, as the time, resources and labour required are optimised, resulting in lower losses, wastage and specimen mortality.

An important improvement for this system would be the use of renewable energy such as solar energy, in order to have a sustainable system that is friendly to the ecosystem.

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