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Tesis

**Control and monitoring system of hydraulic  
parameters for rainbow  
trout culture**

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# Control and Monitoring System of Hydraulic Parameters for Rainbow Trout Culture

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**Abstract—** This research presents the design and control of an automatic monitoring system of the main water parameters for rainbow trout culture, which is a freshwater species distributed in the high Andean zones along with the Andes mountain range, which will be given through mechatronic systems. This work presents the control and monitoring of temperature, dissolved oxygen level, pH, and water level independently so that monitoring and control are simple. The procedure shows the use of different sensors that capture the water parameters such as the use of a Ceratex analog sensor to measure the pH, also the PT100 that will help us to calculate the temperature, and finally an Oxymax sensor for dissolved oxygen, all this helps us to extend the species and prevent its extinction, For the part of the programmed environment the information will be sent and displayed in the visual environment of the system, parallel to this the controller will act based on the information received, to maintain the water parameters in the appropriate range for rainbow trout, which are dissolved oxygen greater than 6 mg / l and less than 8.5mg/l, within the temperature level, the species lives in waters of 9° to 14° C and with a pH of 6.6 to 7.9. In addition, the automatic mechatronic system implemented will facilitate and improve the monitoring and control of water parameters for rainbow trout culture.

**Keywords—** Control, monitoring, aquaculture, automation, rainbow trout culture.

## I. INTRODUCTION

Aquaculture is an activity that takes place around the world, dedicating itself to the cultivation of different aquatic species, in Peru the first species to be cultivated was the rainbow trout (*Oncorhynchus mykiss*), this activity is mainly developed in the high Andean areas [1,9 ] and is supported by Law No. 27460 [18]. The production of rainbow trout in Peru has been growing in recent years and its main market is the national one with 96% consumption of the total production and the remaining 4% goes to the international market [19].

The breeding takes place in concrete ponds, stone masonry, and earth, to obtain good breeding of the trout it must be in a hostile environment where it can develop, for this it has to comply with parameters on the quality of the water. Within the quality of the water are the parameters of dissolved

oxygen (O<sub>2</sub>), temperature (T °C), and the potential of hydrogen (pH).

By not taking into account the adequate amount of each of these parameters, rainbow trout can suffer from viral, bacterial, fungal, and parasitic diseases where the most common diseases they suffer are Saprolegniosis and *Ichthyophonus hoferi* [2].

Within the parameters the temperature is very important, it regulates the growth of the trout since they cannot regulate their body heat, if the temperature is low the growth is low, therefore in high the development is faster, another parameter that is affected by temperature is dissolved oxygen in water since dissolved oxygen is lower at low temperatures [3]. Dissolved oxygen helps trout metabolism so that it can interact with other processes [4].

In previous studies, it was proposed to develop monitoring by IoT module with the aim that users can view certain parameters through a server from any location [5]. In the exhaustive analysis was carried out to probe the odorous molecules in earthen ponds for aquaculture of rainbow trout, different methods were applied, in total 54 odors were detected [6]. In mentions smart monitoring and automation in aquaculture using parameters (pH, temperature, water level, and humidity) where they are obtained by sensors and controlled by ESP32 and can be monitored through a mobile application [7]. In similar to mentioned, only using the Arduino microcontroller [8].

Specifically monitoring the water quality of rainbow trout in a continuous flow, thus comparing the entry and exit of the farm [10]. In the implementation of grape pomace (OU) is given to measure growth performance and digestibility where they carried out two experiments, the first was that it consumed 0.20, 40, and 60 kg of OU in the second it was 0.60, 120, and 180 kg where the 60 kg OU is beneficial for nutrient digestibility and feed conversion efficiency [11]. The research determines the impact of water quality on lipid oxidation, protein, and DNA damage in cultured *Oncorhynchus* tissue [12].

Among the effects that water causes when it is not monitored correctly, salinity varies, which causes changes in the metabolism of fish, either nutrition [13]. As salinity is an important factor in the aquatic environment as well as stress which affects the development of the species such as its dimensions, pH and minimizes responses to risk situations,