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Proposal of Automatic Control System for the Pumping of a Shrimp Farm in the Town of Pimientillo, Nayarit

Propuesta de sistema de control automático para el bombeo de una granja camaronera en la localidad de Pimientillo, Nayarit

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Abstract

The following project pretends to make a proposal to automate the pumping process for oxygenation in a shrimp farm of the company Loma de las cayotas, in order to reduce errors or accidents, which could generate product losses and overuse of energy, decreasing the income of the company. The oxygenation of water for shrimp farming is done by pumping water from the sea. For this process, a scale prototype was developed by automating the pump that will be used in the shrimp farm, which will act according to a selected sensor and the water level increase due to the natural tidal effect. The automation aims to reduce the uncertainty of incorrect oxygenation of the shrimp during its growth period. The process will be carried out with Arduino, a free hardware and software platform.

Shrimp farm, Arduino, Automation

Resumen

El siguiente proyecto pretende automatizar el proceso de bombeo para la oxigenación en una granja de crianza de camarón de la empresa Loma de las cayotas, con el fin de reducir errores o accidentes que se puedan presentar, generando pérdidas de producto, sobre uso de energía mermando los ingresos de la empresa. La oxigenación del agua para la crianza del camarón se realiza mediante el bombeo de agua proveniente del mar. Para este proceso, se desarrolló un prototipo a escala automatizando la bomba que se usará en la granja camaronera, que actuará de acuerdo a un sensor seleccionado y al aumento del nivel de agua debido a efecto natural de marea. La automatización pretende reducir la incertidumbre de una incorrecta oxigenación del camarón durante su periodo de crecimiento, la cual se llevará a cabo mediante Arduino que es una plataforma de hardware y software libre..

Granja de camarón, Arduino, Automatización

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Introduction

In many parts of the world, development is promoted through the implementation of technology that facilitates processes and activities, from the most basic ones, to the most complex and specialized. Shrimp production on farms is subject to different variables such as nutrition, food, oxygenation and biological variants which generate changes in the quality of water and pond soil.

The gaseous oxygen dissolved in water is vital to the existence of most aquatic organisms. The concentration of dissolved oxygen (DO) in an aquatic environment is an important indicator of environmental water quality (Galli Merino, 2007).

For intensive aquaculture, it is prudent to keep the incoming water as close as possible to the total DO saturation (100%), (Blanco, 2005).

Shrimp farms have presented good development and benefits for the owners and so, they are now an important part of the state of Nayarit, the process of water oxygenation being a fundamental part for quality production of shrimp.

Currently, the existence of farms with automated systems for the filling of shrimp farms and water oxygenation is practically null in the country, because the focus is on fish production. The prototype will mainly help facilitate the work of the person who performs the daily activity; this is an improvement for the process or operation of the farms through sensors and microcontrollers, benefiting from the physical phenomenon of tides.

The field trip provided first-hand information regarding the needs of the entrepreneur, which are: the rustic way of handling their shrimp farm network and the feasibility of carrying out the project. Practically, all the Pimientillo region of shrimp farms has electricity. According to the problems found, the proposal for a feasible or viable solution considering the investment and the benefit of the farms is the Arduino and its programming. Arduino is a free software platform, the use of labview is not considered necessary for the implementation of the project, but it was carried out to observe how this automation can be scaled.

Methodology

A project for the automation and control of the filling of a shrimp pond was carried out in the town of Pimientillo, municipality of Tuxpan, state of Nayarit, Mexico, to reduce expenses from shrimp sales by paying the night shift to the operator and avoiding losses due to distractions and human errors that end in shrimp and income losses for the owner, for not performing the corresponding water oxygenation of the day.

According to the aforementioned, the automation of the pumping and drainage system for a shrimp culture will be carried out through circuits, level measurement sensors and actuators.

Having an automated system within the farm is very reliable and effective, since it would eliminate operator oversight when performing their pump on and off activities during the entire time the tide is high, as well as reducing labor costs because a person will no longer be needed for such activity.

Before describing the procedure, it is important to mention that the level or degree of oxygenation is not measured before or after the water pumping process. Everything is managed empirically and is knowledge passed from generation to generation, which determines the time of daily water pumping to the farms, hence no results regarding this aspect are shown.

The complete project includes measuring the degree of oxygenation and improvements in shrimp farming, the progress of the project and the article. It is limited to the automation of the process of pumping water for oxygenation, keeping in mind that it is of great importance to measure this variable.

Activities: Some of the activities that were proposed for the project were:

1. We analyzed a problem and looked for possible solutions.
2. We went on a field trip to learn the physical and environmental conditions where the problem was.
3. We proposed each of the stages that a project entails and we dedicated time for the elaboration of each one of them.
4. We designed the plans with the distribution and structures of the

prototype, as well as the programming and facilities it will need.

5. We carried out the acquisition of the necessary material for the realization of the prototype; we also got some recycling materials.

Tools, equipment and machines used.

– Truper copper tipped soldering iron.
– Cross and blade screwdriver:
  Standard measurement, acetate plane measured 1/8x3.
  Adjustable wrench with 6” lining.
  ½ type 58d34 high speed steel drill for general purpose.
  110V electric drill.
  Cutting, pressure and mechanical clamps.
  10” straight pressure clamps, standard mechanical 9” cutting clamps.
– 40 ounces curve hammer.
– Circular grinder with diamond disc (cricket).
– Flexometer.
– Protoboard.
– Cutter.
– Voltage source (5 to 24 V).

Figure 1 shows how the farm is currently working by means of a standard turbo diesel engine. We propose to implement an electric pump that activates automatically through an automated control, facilitating the filling process on the farm and avoiding hours of filling and manual labor.

Figure 1 Current pumping in shrimp farm

Figure 2 shows on a simulated scale the position where the turbodiesel engine is located in the shrimp farm, the change would be from the engine to an electric pump, automated by means of a level sensor.

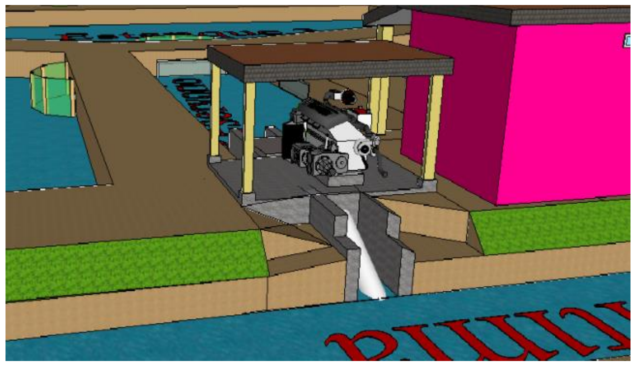

Figure 2 Pumping structure

Figure 3 shows a preliminary design of the physical or flat distribution of the shrimp farm and its divisions, which are: 3 ponds, a reservoir and the sea vein, from which water is taken to fill the farm by means of the engine shown in figure 2.

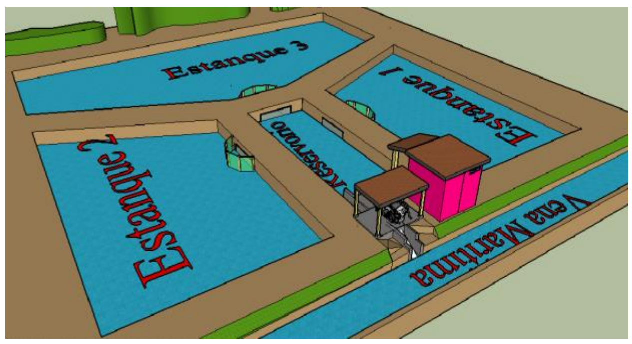

Figure 3 Shrimp Farm Distribution

Figure 3 shows the complete distribution of the farm, the area where the pump is located, as well as the house where the operator fulfills the function of turning on the pump when the tide rises and reaches a desired value, that is, to reach the hose or suction tube, while the tide is rising, which keeps the pump on and carries out the process of water oxygenation, once the tide drops, the operator will turn off the pump. The process usually takes place in the late evening.

Figure 4 shows the electrical connection, the part of the Arduino in connection with the protoboard and the ultrasonic sensor.

The sensor has the features of measuring range of 2 cm to 4 meters maximum, an accuracy of +-3mm, current consumption of 15 mA and operating voltage of 5V, which will be applied to measure the level of the tide, simulated with a vessel increasing the water level, as explained below.

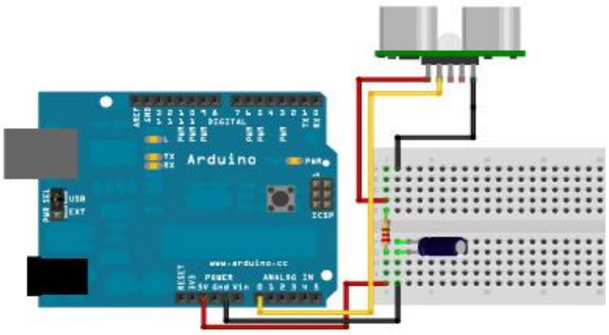

Figure 4 Arduino and ultrasonic sensor

Once the connections were made, the programming was only for the sensor and Arduino, through C language.

The routines were programmed so that the sensor acted by turning on a LED when it detected the level that was established in the programming and turned off when the level was below. Within the programming a time delay for the pump operation was placed, to avoid false level measurements by surge in the area, which in this case is a small channel where the suction tube is located.

Once the programming was completed, the Arduino plate was placed on a container and pumps were connected schematically, as seen in figure 5.

With this, the programming and the time delay were validated before a disturbance of the measured signal (level); the manual valves simulate the effects of the tide and the pump, like the one that injects water into the ponds, these being the models shown in figure 3.

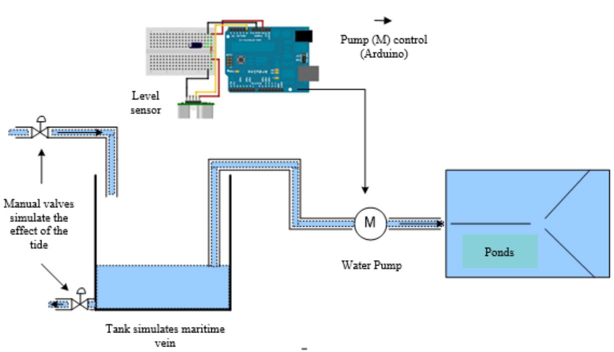

Figure 5 Programming Validation

Once this was done, the interface in the Labview program was programmed as a visualization and control system of the activation and levels.

Figure 6 shows that once the water reached its level, the tank is filled with the river level label. And the tanks that have the label major river level minor river level are those that adjust to the values of turning on and off (delay) the seawater suction pump to oxygenate the ponds.

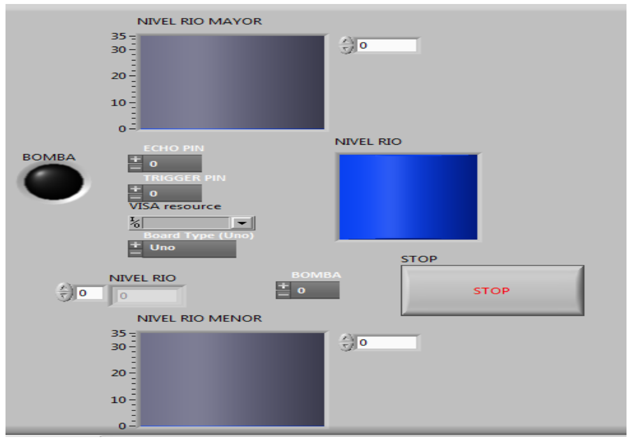

Figure 6 Simulation in Labview

Figure 7 shows the block diagram of the Labview program which performs the process of level comparison, as well as the visualization of the variation of the water level simulating the tide. When the LED on the display on the Labview front panel was turned on, the pump was turned on, indicating that the established conditions were met.

The conditions of the process are: with the sensor it will detect the presence of water at a distance of 5 cm; it will send a signal to the Arduino and through this, the pump will be activated and start filling the farm; as the farm was filling, the water of the container outside decreased until the distance of 2.5 cm is reached; the sensor detects the distance and also sends a signal to the Arduino, turning off the LED and deactivating the pump, stopping the oxygenation process.

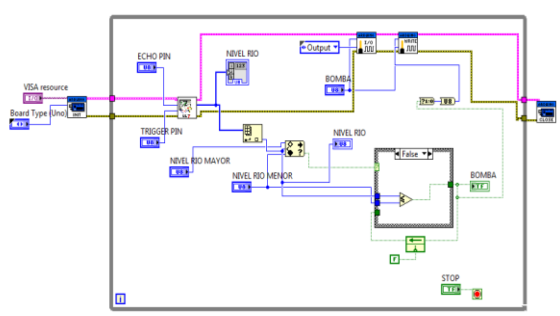

Figure 7 Labview block diagram

Results

Figure 8 shows the complete and physical prototype with its electrical connections, which are not visible since it was part of the requirements for the presentation. The prototype was made to scale for the simulation of the main objective, that is, the automation of a pump. Figure 8 also shows the divisions of the ponds already filled with water, a drain pipe and the part of the pipe where the water flowed through the pump.

The pump used was of 24 V, so a power arrangement was made to condition the signal, since the Arduino handles 5V output voltages.

Figure 8 Physical prototype

Conclusions

After the installation and placement of the prototype, the electrical/electronic and structural part worked correctly. The initial test is only the filling control of the tank based on the level of the simulated tide with a container with the Arduino. Level sensor and pump functioned correctly, when adding the visualization and control by means of the Labview software the result was satisfactory, having the plus of observing the change of the level variables and the pump drive.

If more automation is required, Arduino has communication components that can extend the monitoring and control of the process remotely.

As a functional prototype, the use of a platform with Arduino is justifiable due to its cost, but if greater certainty is required in the equipment, the use of more specialized and robust equipment in industrial settings such as the PLC is recommended.

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