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Development of a Low-Cost System for Monitoring Water Quality applied to Fish Culture

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Abstract*— *In fish farming, automation is an outlet to minimize and / or optimize some key points for business success, such as real-time monitoring of water quality and its intervention when they are changed, as well as their interface with other productive management practices. The monitoring of water quality is done through the verification of some chemical and physical parameters, requiring qualified personnel to measure and interpret these parameters in order to provide a good water quality necessary for the good productive performance of the species to be cultivated. In this context, the objective of this project is to analyze the feasibility of implementing a low-cost computer system to monitor the physical and chemical properties of water in aquatic organisms. Taking into account the existence of a wide variety of technologies available on the market that can be used together, this work aims to study the paradigm of automation and its use in the field of fish farming, making use of existing technologies with Arduino, Raspberry pi and sensors. Finally, we intend to analyze the financial feasibility of developing a computer system to monitor the physical and chemical parameters of water in aquatic organisms.
***Keywords*— Automation, Computing, Fish farming, Internet of Things.**

I. INTRODUCTION

Automation can be defined as a set of techniques that, applied to a process, aim to make it more efficient, thus maximizing its production, reducing energy consumption and time, reducing waste emission and improving the safety conditions that are inherent to the process [1]. It is worth mentioning that the automation process takes place in two basic chains, using automatic software to perform a certain task, or only hardware, without using software, purely mechanical, e.g.: ram pump, we also have electromechanical. Example: vibratory pump and the combination of the two modes, hardware and software, with this, implementing an intelligent system, able to reprogram, readapt or even evolve depending on the manufacturing paradigm used.

The evolution of computing has led us to the miniaturization of the hardware and consequently its low cost, with this making its acquisition and its combination possible for the development of control and automation of the processes, providing to its users in the agricultural environment an autonomy, in routine , previously unimagined, that can be used adaptively in several production processes of fish farming, with minimal changes and with little impact on cost and a great impact on the benefit. The screen-based research aims at exploring the viability of the production cost of an automatic and scalable system for water monitoring, initially the study is about its applicability in excavated nurseries, using modulation techniques, making it expandable and adaptive the needs of the fish farmer. In addition, it becomes a set of solutions for everyday situations by promoting benefits directly linked to the production and greater performance of the activities of the producers.

Automation should be advanced by agriculture and livestock as a way to ensure increased production and productivity in Brazil and still maintain and stimulate the growth of agricultural machinery and equipment industries. It is emphasized that the interest of multinational companies in the growing opportunities of Brazilian agribusiness is increasing the investment in automation. Thus, to remain competitive, it will be increasingly important that the Brazilian machinery and equipment industries generate innovations that can improve the performance of the activity and broaden the range of activities served. A good strategy to achieve this

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goal is the expansion of partnerships between industries and public and private research institutions that foster research.

II. STUDIES DEVELOPED IN BRAZIL

Embrapa (Brazilian Agricultural Research Company) has been acting and consolidating itself as a user and developer of automated methods and equipment. An example of this is the work agenda of Embrapa instrumentation (São Carlos, SP), created in 1984, which inaugurated on September 20, the National Reference Laboratory for Precision Agriculture (Lanapre), prepared to create new and strategic partnerships with public and private companies. In fact, Lanapre was already inaugurated as a joint research unit in partnership with the University of São Paulo (USP) and the Federal University of São Carlos (UFSCar). In addition to research networks in progress, related to the theme, Embrapa is also implementing a PD & I (Research, Development and Innovation) Portfolio in Agricultural, Livestock and Forestry Automation [2].

With the objective of developing a quality product using technology applied to agriculture, the present work aims to study the feasibility of creating a computer system capable of collecting information on the chemical and physical parameters of water in excavated nurseries and, and then send it to a database, allowing real time monitoring of water quality, allowing the analysis to be obtained over time, generating a history of physical and chemical changes of the analyzed environment.

III. THEORETICAL REFERENCE

Several areas have pointed out the benefits that technology has brought, in its generality, to society, great benefits in terms of automation, information and knowledge. In relation to companies, technologies mean higher productivity and gain in competitiveness. Technological advancement, especially in the field of computer science and information, is supported by a body of intelligent software development. Technological innovation has become an extremely important indicator for the substantial growth of agriculture, working in an interdisciplinary way and using technology as a tool for resolving real problems, we can have a better efficiency and productivity of the researched object.

DEVELOPMENT PLATFORM

We chose the Arduino UNO platform as a micro controller, firstly to work with free software and to be relatively cheap and scalable, greatly reducing project costs, and can group several sensors for automatic monitoring, McRoberts, (2011), defines the Arduino as: [...] a small computer that you can program to process inputs and outputs between the device and the external components attached to it (Figure 1). Arduino is what we call a physical or embedded computing platform, that is, a system that can interact with your environment through hardware and software. [3, p. 23].

It is important to emphasize that with the wide diffusion of this technology and consequently its low cost, several areas of research such as engineering, medicine, industry in general and especially in the agricultural field can be perfectly employed, thus increasing productivity and reducing errors in the collection and later analysis of the data, when compared to the usual environment, manual collection *in loco*.

COMPUTER SYSTEMS

The screen search is supported by computer networked systems, which can provide the farmer with a range of information in real time and anywhere, allowing to use free or commercial platforms. By computer system, Reisswitz, (2012), defines as a set of electronic devices (hardware) capable of processing information according to a program (software). The most important software is the operating system, it provides the bases for the execution of the applications, to which the user wishes to execute, the choice of set, hardware and software is that determines the cost, our work is based on the use of free software , based on linux, thus reducing project costs, so the author defines hardware as: The hardware corresponds to the electronic and mechanical parts, which allow the existence of the software, the storage of information and the interaction with the user. The CPU, the primary and secondary memories, the peripherals, the computer network components, are examples of hardware elements. [4, p. 51].

Thus, an automated system can allow the existence of several systems and a system can request several computers or tasks to be processed, generating a range of data that can be refined, grouped and analyzed with data mining techniques, subject for future work, the software is defined by the author as: The software is the abstract part of the computational system that works on hardware from instructions encoded in a programming language. These instructions allow the processing and storage of information in the form of encrypted data and can be controlled by the user. This control, as well as the exchange of information between the user and the system is done through the user interface, made up of hardware and software [4, p. 51].

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Being the software the logical part, abstract of a computational system and combined with sensors, can be applied in the same computer system, to collect information in real time, such as water temperature anywhere in the nursery, pH levels, Nitrite, Alkalinity among others, thus, the system becomes scalable according to the need of the fish farmer, that is, one or several sensors can be used in the same computational system as they are necessary for monitoring the environment.

IV. MATERIALS AND METHODS

The methodology is based on an exploratory research, as it seeks a detailed technical and financial feasibility of the prototype to be used. [5], defines this research as: These researches aim to provide greater familiarity with the problem, in order to make it more explicit or to constitute hypotheses. One can say that these researches have as main objective the improvement of ideas or the discovery of intuitions. Its planning is, therefore, very flexible, so that it allows the consideration of the most varied aspects related to the fact studied. [5, p. 51].

In this sense, exploratory research is used when there is little knowledge about the subject to be approached. Since the area of fish farming is the delimitation of the research, and through this study, we seek to know the subject in depth. In the words of [6] one of the characteristics of the exploratory research is the deepening of the preliminary concepts about a certain subject not satisfactorily contemplated previously.

Clarified the method used in the research and after a better understanding of the need to solve the proposed problem. Initially we did a theoretical revision of the concepts involved, both those related to automation and control and fish farming in their physical chemical aspects, to better understand the technology team involved. After that, we held meetings with the professors of the agricultural sciences, in order to collect information necessary to model an automated system for fish farming. In this way, we surveyed the hardware and software needed to create the prototype, thus defining which minimum equipment is required to mount an automated and inexpensive system.

After the process of recognition of the object being searched, we conducted a price survey on websites and catalogs of computer companies to verify which one has the most economically feasible value for the proposed purpose, and finally we end with the final report of the activities.

We used as initial parameters, the work of [7] that brings in its core, the monitoring of the ideal levels of water quality to reduce losses where, it is sought to develop an automatic water analysis system for aquaculture using the platform Arduino Mega with sensors of temperature, pH, ammonia, among others.

Thus, in consonance with the work of Huet (1978), *apud* [8, p. 2], which is determinant in an aquaculture model and the best cropping system to be implanted is the quantity and quality of the water and in the end, after studies and field visits, we can better understand the process and the real needs of automation, finalizing with the descriptive survey of the hardware and software and to be used in the assembly of the prototype.

Finally, as the proposal is of an interdisciplinary nature, the results collected and parameters for measuring water quality for fish culture will be monitored by a specialist in the area.

MATERIAL TO BE USED IN THE INITIAL PROTOTYPE.

The methodology applied in this research is an exploratory one based on a rigid bibliographical revision, relevant to the proposed theme and with a view to the future implementation of a prototype for tests. The purpose of the study is to demonstrate that it is possible to have a more efficient and low-cost control with automation, that is, reports can be obtained at any time of the physical-chemical state of the water according to parameters agreed for the production. Below is shown some equipment needed for assembly of the prototype for tests in real nursery.

Fig.1: Arduino UNO

Arduino Uno, Figure 1, is an electronic prototyping platform that operates under free software. Its interface allows us to operate a variety of sensors, both digital and analog.

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Fig.2: Module ethernet shield W510

The Ethernet Shield module, Figure 2, allows the Arduino board to connect to the Internet, provides access to the Internet Protocol (IP), Transmission Control Protocol (TCP), and User Datagram Protocol (UDP) protocols.

Fig.3: Temperature sensor

In Figure 4, we have the temperature sensor, which will be submerged collecting in real time the water temperature, with precision of: +/- 0.5 ºC between -10 ºC and +85 ºC, it is sought to monitor the physical appearance of the Water.

Fig.4: pH Sensor Module

In Figure 5, we have the pH-sensor module of liquids, thus ensuring real-time monitoring of the environment, and can be implemented for alert or even automatic correction procedures.

Fig.5: Turbidity Sensor

We have in figure 6, the turbidity sensor, electronic monitoring module to work with the micro controllers Arduino and others. Capable of detecting particles that are suspended in water, measuring the transmittance of light and the dispersion rate, which changes according to the amount of total suspended solids.

V. CONCLUSION

The exploratory research developed showed favorable conditions for the creation of an innovative, scalable and low-cost computer system. Autonomy is the main point of creation of the system, allowing the researchers the best understanding of the object to be searched. Fish farming requires a constant dedication, using techniques that require a shift to collect information, today, the small or large fish farmers can have the same information in real time and anywhere, facilitating their daily work for better management and decision making.

As future works, it is intended to develop an automated computer system for data collection in fish nurseries, with the purpose of optimizing the process of collecting physical chemical information of the environment, it is also worth noting that the present work, through its methodology , provided a greater understanding and consequently a greater learning in relation to the proposed theme, besides envisaging a potential solution at a low cost for fish producers in excavated nurseries.be modularized according to the need and the precision of the monitoring.

The average amount budgeted for the purchase of devices to be used in the project amounted to $ 140.00 Dollars, value found in the market in February 2019, in online stores

We can conclude that the cost is relatively low, when compared to ready-made systems sold in the market. As a pilot project, for the on-screen study, only the basic sensors cited above, according to a meeting with professionals of the area, were budgeted as basic sensors for the monitoring of fish breeding systems. I stress again that the proposal is to have an expandable system, and

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can be coupled and programming more sensors to the module when you need it. As for software, there is no budget expenditure, since we will use free software.

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