Automatic Monitoring System and Fish Feeding for Fish Farming in Tanks

Elmo Batista de Faria
Computer Institute of Federal University of Mato Grosso
UFMT / Cuiabá, Brazil
Email: elmo [AT] ic.ufmt.br

Gustavo A. Oliveira
Electrical Engineering of Federal University of Mato Grosso
UFMT / Cuiabá, Brazil
Email: gustavo.alecio2 [AT] live.com

Miguel R. J. Martins
Control Engineering of Federal University of Mato Grosso
UFMT / Cuiabá, Brazil
Email: miguel.rjm98 [AT] gmail.com

Antônio Cândido da Silva Filho
Technology Secretary – SECITEC/MT
SECITEC / Cuiabá, Brazil
Email: antoniocandido [AT] secitec.mt.gov.br

Abstract—**The approach consists of an information system able to monitor and act on the process of fish farming in the environment of confinement of excavated tanks. In this work we present all the components of the microprocessed and managed system by mobile APP.**

Keywords-component: monitor; fish farming; microprocessed; mobile APP;

I. INTRODUCTION

The indoor fish farming system lacks technology in all of your stages of production. The current system consists of simple management without the use of automated techniques for control or monitoring, the quality of the fish is directly related to the water quality and its treatment process. The monitoring and control of the farming are still done by people or fish farmers who, depending on the fish species, use from their expertise acquired in years of experience and common sense knowledge.

This proposal aims to suggest a system based on specialists' knowledge and scientific basis to create an automated process of fish farming. It includes the treatment system and the measurement data related to the quality of the water and of the environment, in order to the expert system (ES) influence the fish farming, treatment, monitoring and optimization in outdoor tanks. [1]

The main data to be monitored is: Temperature measurement of the water and environment; Estimated Oxygen dissolved in the water; pH monitoring; Water turbidity; Wind speed; Rain level; Among others. The proposed systems are divided in two stages. The first stage is in the feeding system and fish feeding expertise.

The second one is in the measurement and monitoring data for water quality of the tank and its environment.

A proposal for the future is a fish size measurement system in real time.

II. DEVELOPMENT

A. General Objective

To develop technologies and innovations in order to contribute to the accurate management practices and fish farming production. This way the small farmer is able to benefit from the knowledge and innovations of precise aquaculture.

Specific Objectives

- To reduce the total cost of fish farming and
- To reduce the use of fish food and diminish its waste
- To develop or adapt specific sensors of water quality measurement
- To develop equipment for automated feeding in pre-determined periods of time.
- To create a specialized system with rules in order to maximize the fish farming process
- To define a centralized management

B. stages

The project is divided in many areas of knowledge, involving varied technologies regarding information processing to be described in this paper, which include the history of the weather conditions from each microregion and time, and of the System acts; Corrections made by the system, the warnings for external corrections (farmer and/or technician), with the goal of improving the productivity; Designed application which will allow the farmer to define the system parameters, which are described in this paper; To make it possible to follow the real time of the farming by comparative graphics, which will show whether the farming is ideal, superior or deficient; To provide the management of water quality and of fish farming effluents in nurseries; Rational use of the supplies and natural resources and

to bring the technological knowledge and technologies to the small farmer in order to improve your quality of life and the sanity of your production.

C. Methodology

The methodology used consists of the construction of a prototype to evaluate the concepts studied, tested in controlled environment in tanks of 1000lts and monitored by cameras.

III. THE SYSTEM

The basic modules are displayed in an interconnected arrangement, as showed in the figure 1. [1]

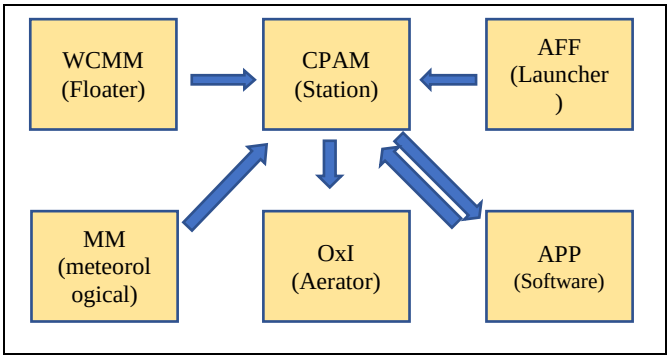

Figure 1 – Diagram of the System Groups

A. WCMM

Water Conditions Monitoring Module (WCMM). Made by some varied sensors, it collects all the essential aspects of ideal water conditions in the reservatory, allowing that a monitoring is done in real time, as well as the adequate corrections, according to the pre-determined parameters.

B. CPAM

Collection, Processing and Acting Module (CPAM). Collection of the float information, the meteorological station (MM), the feeder, the perimeter monitoring and it corrects and acts according to pre-determined parameters.

C. AFF

Automated Fish Feeder (AFF). With mobile technology configured by the app SAMAPE on a mobile phone, tablet or notebook, it permits the farmer to determine the best fish feeder program, improving the productivity, the supplies use, the water quality, the lot sanity and the environment protection.

D. MM

Meteorological Microstation (MM). Besides making a historical record of the weather conditions, by the app SAMAPE, it is done a monitoring of the aquaculture real conditions, in real time, and parameters which influence the farming, such as: temperature, wind speed and precipitation.

E. OxI

Oxygen Injector (OxI), integrated to the CPAM and made of microporous hosepipe, it injects the oxygen directly into the water, only activated when the oxygen level is low, increasing the efficience of oxygenation and reducing costs.

F. APP

Application (APP) SAMAPE. The application was developed by using mobile technology, to be runned in any mobile phone. With the app, both the fish food release and the tank oxygenation can be controlled, besides the monitoring of the main measurement units to evaluate the production, such as temperature, pH levels, wind speed, rain level and among others. The software uses rules based on a Specialized System to reach a decision.

IV. DEVELOPMENT

With the use of the resources from the precision Agriculture laboratory, at the Computer Institute, for the prototypes manufacture and programming models, the feeder and the oxygen injector are already being developed, besides the measurement float being tested.

System components:

a) Microcontroller ESP32

The ESP32 is a 32 bits dual-core microcontroller with wifi and integrated bluetooth 4.2 (BLE), it has around 500 kBytes of SRAM memory, which makes possible that more complex programs run, and it is present in an easily accessible board, the NodeMCU. There is the possibility of integration with the Arduino IDE and this way to have access to a certain variety of compatible libraries, facilitating the programming and the load over this Interface.

The microcontroller also consists of a CAN Network controller, which allows the module to interact with this kind of network (e.g. CAN network in vehicles, trucks and tractors). There is also an Ethernet MAC interface in it and that makes possible to put the module in a wired Ethernet network.

Another important function is the possibility of using Debuggers to monitor and follow the microcontroller code execution in real time, by the JTAG interface. Some aspects are detailed in the figure 2.[5,6]

Specifications	ESP32
MCU	Xtensa® Dual-Core 32-bit LX6 600 DMIPS
802.11 b/g/n Wi-Fi	Yes, HT40
Bluetooth	Bluetooth 4.2 and below
Typical Frequency	160 MHz
SRAM	512 kBytes
Flash	SPI Flash , up to 16 MBytes
GPIO	36
Hardware / Software PWM	1 / 16 Channels
SPI / I2C / I2S / UART	4/2/2/2
ADC	12-bit
CAN	1
Ethernet MAC Interface	1
Touch Sensor	Yes
Temperature Sensor	Yes
Working Temperature	-40℃ ~ 125℃

Figura 2 – Aspects of the Microcontroller Esp32

- Maximum continuous current (W) 60s = 478W
- Max Impulse = 770g with the use of 40ª Recom.ESC

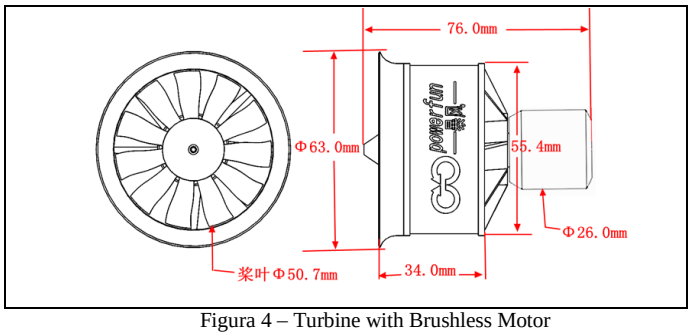

Figura 4 – Turbine with Brushless Motor

c) Feeder

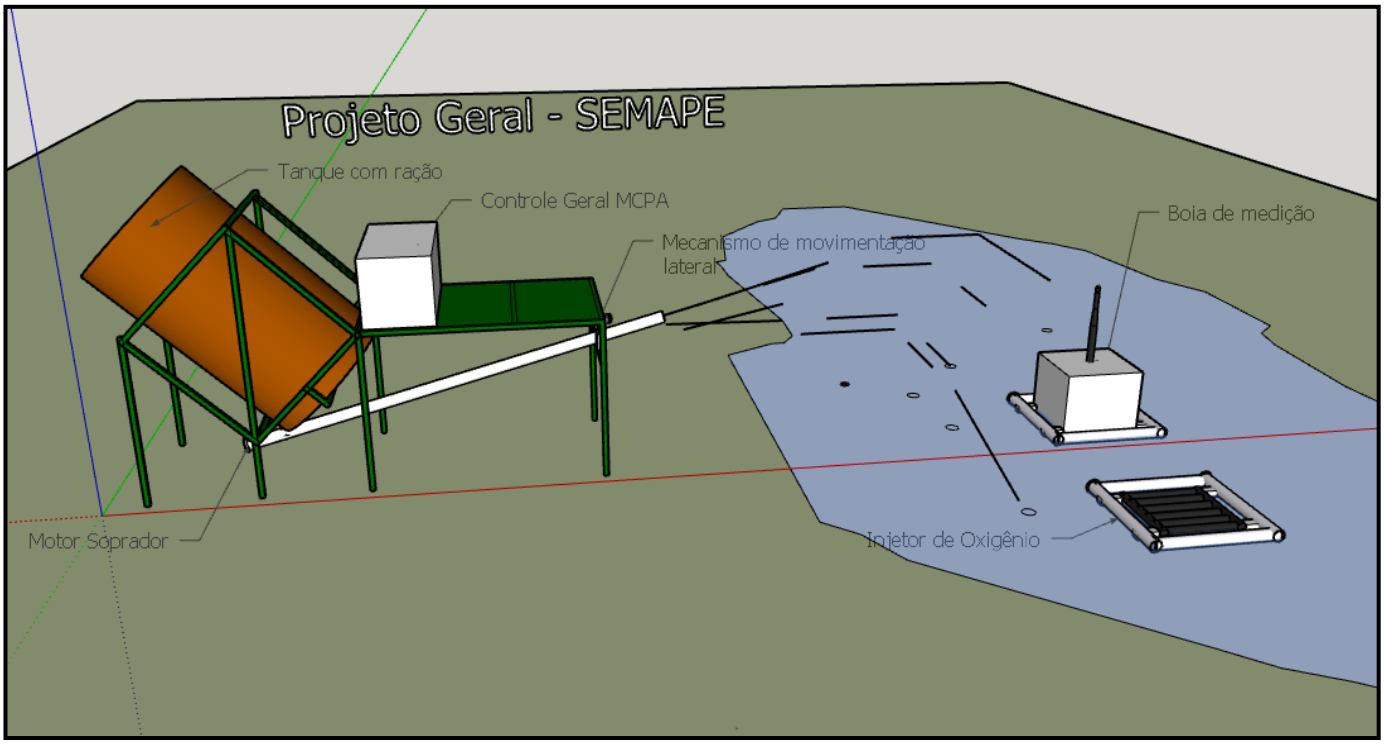

Figura 3 – Sistema Geral do SEMAPE

The general diagram of the System is presented in the figure 3.

b) Brushless Turbine

For the fish food release a brushless motor set (figure 4) and a turbine were used, commonly applied in aircrafts, its construction is of a motor without brushes. This motor was tested in experiments and showed not only a stable performance but also a resistance to high temperatures. It also has an 11-blade propeller. The basic electrical and mechanical specifications are:

- Voltage (V) = 12V
- Maximum continuous current (A) 60s = 38A

Characteristics of the data collection system and the activation of the fish food release (CPAM), showed in the figure 5:

- It has a small station to measure external metereological measurement units to the tank
- It enables the communication with the other modules, both to the water oxygenation (OxI) and the measurement float (WCMM)
- It enables the communication with the installed APP on a mobile phone for manual control and adjustment of the automatic system parameters.

- Throwing system with a blower
- Throwing with angle variation (vertical/horizontal)
- Multiple timetable activation programs
- Multiple programs for the amount of fish food release
- Multi-tanks feeding
- Marker for the fish food reservatory level
- Actuator of the fish food reservatory level
- Integrated to the Collection, Processing and Performance Module – MCAP
- Internet 3G/4G/Wi-fi
- Anemometer that aims oxygenation and gale warnings.
- Electronic windsock and environment temperature gauge.
- Feeder controller.
- Moviment presence sensor (light, alarm and camera).

Alarms which warn the farmer when the energy and fish food are missing.

Figura 5 – Feeder with fish food depository

d) Measurement float

Characteristics of the measurement float and of the water monitoring, which can contain:

- *pH sensor*
- *Dissolved Oxygen Gauge*
- *Ammonia gauge – toxic from 0,6 to 2,00 ppm*
- *Nitrite Gauge and CO2 Gauge*
- *Thermometer – water measurement temperature – about three levels*
- *Alkalinity sensor*
- *Turbidity (Secchi Disk)*
- *Presence sensor (which can activate a device to scare predators of fish and fish food away)*
- *Alarms and infrared*

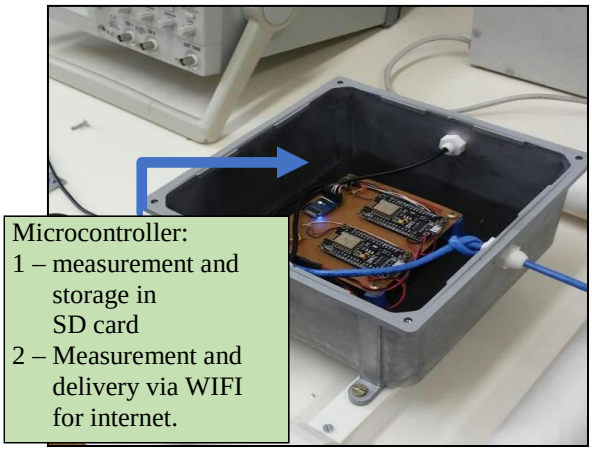

Figura 6 – Water quality measurement float

e) Oxygen Injector

Characteristics of the oxygen injector (figure 7):

- Microporous hosepipe
- PVC Structure
- Actioned by CAPD

figura 7 – Oxygen injector

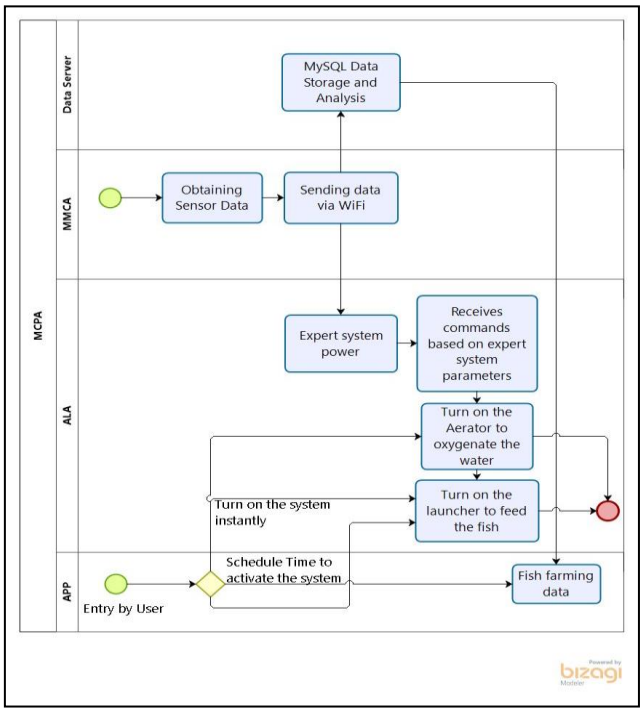

Figure 8 – Control Application for mobile devices

f) Control software for mobile devices

The software was designed in WEBAPP, application for smartphones, which has an internal server to show web pages, customized and formatted for the screen of the devices. It works both in Android and IOS. The diagram in figure 8 shows its main elements and functions. [2,3]

Based on the specialized systems, artificial intelligence programs made from the emergence of powerful machines and the laws of thinking, the APP has as its principle the execution of a logical algorithm of cause and consequence, added to the execution of conditionals and human decision making.

A expert system is able to emulate a specialized human being's competence, these are mainly designed to solve complex problems, by means of reasoning by knowledge sets and not by rules in a procedural and conventional process. In the specialized systems there are the knowledge basis, inference motor and user interface. Figure 9.[4]

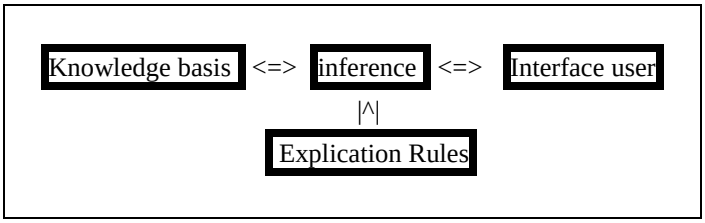

Figure 9 – Reverse chain

The knowledge basis is where the complex information, both structured and non-structured, is stored. The foundation of this knowledge basis is made of the information collection according to a specialist's knowledge. This information is classified and organized in the "if-then-else" design, in order to be used by the inference mechanism.

The inference mechanism uses procedures and rules to reach a correct conclusion. With its help, the logical rules are applied on the knowledge basis so new information is deduced.

For the recommendation of a solution, the inference mechanism uses the following Advanced Chain and Reverse Chain strategies. [4]

With the advanced chain (showed in figure 10), there can be found the answer to the question: "What can happen next?"

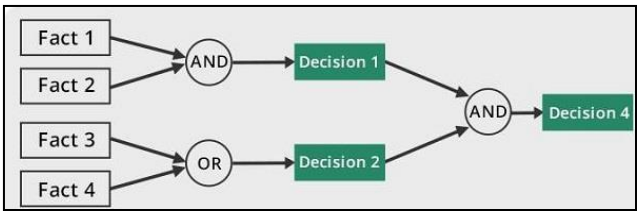

Figure 10 – Forward chain rule

With the reverse chain (showed in figure 11), there can be found the answer to the question: "Why did it happen?"

Information is collected, such as the fish species to be bred and the reservatory size, also the water quality measurement, this way feeding the system that helps in the process of decision making.

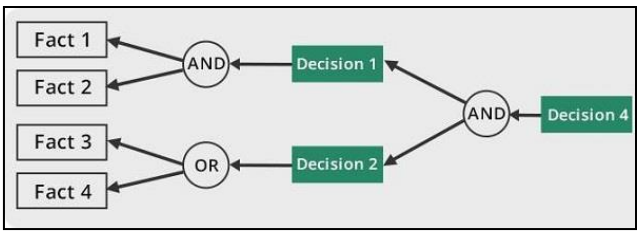

Figure 11 – Reverse chain

In figure 12, there is the interface with the user, showed on the smartphone, with its main functions and, at the end, an indicator of the water quality at the moment of the checking.

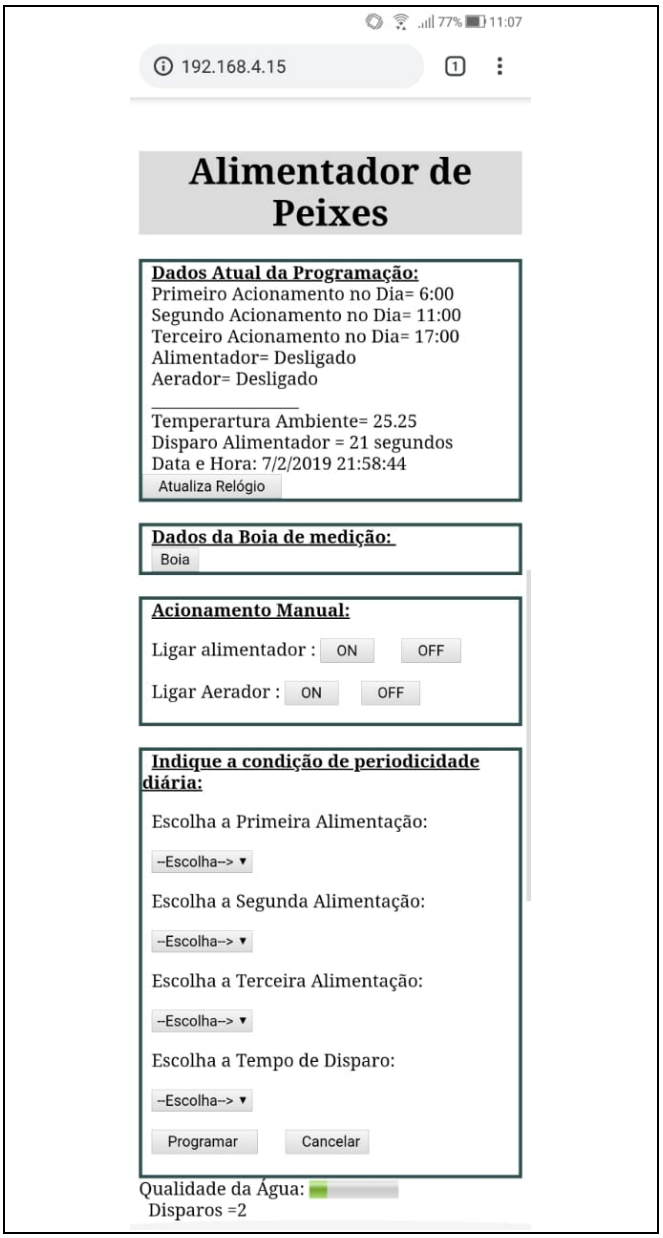

Figura 12 – App Semape

FINAL PRODUCTS

The research done in the last years produced an automatic prototype to feed fish, control the water quality and the oxygen injection system.

Production of scientific papers and technical book, other monitoring technologies and parameters correction, including:

- Circuits and Electronic equipment
- Applications on Monitorings
- Applications on Corrections
- Interaction and Communication.

V. CONCLUSION

The programming models are being designed and are already being tested, such as the measurement float, the feeder and the oxygen injector. Figure 13.

To do so, microcontrollers with access to WIFI are being used or data collectors by SD card, in order to feed a database dedicated to the information collection. This information is paramount to enhance the systems and create a database of the environment conditions to the automating process of indoor fish farming. The results of the prototype have showed this is a viable alternative and also a low cost one. The water quality also was noticed to be an important factor to keep a great productivity and guarantee the health of the fish. The application based on mobile system is easy to use and follows all the feeding process and the measurement of the water quality parameters. The Artificial Intelligence techniques must be perfected in order to guarantee that the decision making process is precise and is according to each fish species which are going to be bred in that process. Also, the specifications of the regions in which the farming intends to start need to be guaranteed to be easily inserted in the system.

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Figure 13 - tanks of 1000lts monitored by cameras.