Control And Monitoring Of A Greenhouse Using Plc S7-1200 And Web Server In High Andean Areas

Santiago Rubiños, Wilver Auccahuasi, Junior Grados, Carmen Diaz, Jhon Ayasta, and Manuel Huamán

Abstract: The present research work is carried out to increase the massive use of new technologies in the agricultural sector, innovating and betting on the development that is theoretical and experimental in nature, with the purpose of encouraging the use of new technologies in order to observe a considerable increase in the production of the agricultural sector with thus leading to a diversification of knowledge in the population for an adequate use of such technologies. For the development, we will first review the existing documentation on new greenhouse control technologies such as the variables: temperature, humidity, luminosity, heating, etc., and finally we will obtain the results with the implementation being verified on a web server of the S7 PLC itself -1200 SIEMENS brand which will help the user to monitor the process or the greenhouse plant in real time.

Index Terms: Invernadero, PLC, Programación Ladder, Web server.

1 INTRODUCTION

For thousands of years man has inherently had the desire to control nature, either properly or for inappropriate purposes. The diversification of agricultural products around the world is an indication of improving and optimizing our production systems, whereby an intelligent greenhouse would be an interesting proposal to develop. A greenhouse will allow us to control and supervise the production of fruits and / or tubers regardless of the climatic conditions of the chosen areas, the production process can even be accelerated by controlling the variables (temperature, humidity, luminosity, others). “The automated greenhouse cultivation system provides a suitable microclimate for the production of fruit, flowers and vegetables. [one]

The advantages of the automated greenhouse system is the higher productivity per m2, the guarantee of having a quality production, efficient control of pests and diseases of the crop, greater control of environmental factors, to produce out of season, have the environmental conditions to produce wicked crops, have more opportunity to market high quality crops in a competitive market. For the design of a greenhouse, it is necessary to know the factors that govern its proper functioning, so an investigation must be carried out with engineers: agronomists, electronics, systems for its proper operation in automation. Which the present research work entitled "CONTROL AND MONITORING OF A GREENHOUSE USING PLC S7-1200 AND WEB SERVER IN ZONES ALTO ANDINAS DEL PERÚ" seeks to achieve optimal solutions for the implementation of this research with an adequate problem statement.

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2 METHODS Y MATERIALS

The idea of this project arises from the Final Master Thesis "Commissioning of a Humidity and Temperature Measurement System in a Greenhouse", developed by the master, Carlos Loor. After its work in the construction of a greenhouse and the control of temperature and humidity, the need arises to be able to monitor the state of the variables in a fast and comfortable way. This is how this project is born, Greenhouse Controlled by a web server of the same S7-1200 PLC, with the purpose of developing services that allow the user to control and monitor the state of the greenhouse from any geographical point. It offers the possibility of modifying working ranges of actuators, managing alarms, visualizing variables ... even being able to draw graphs of evolution of the parameters involved in the process of planting growth. The need of the human being to control their environment and modify it based on their needs and the search for man to achieve a more comfortable and safe life, are the pillars that drive this project. [2]

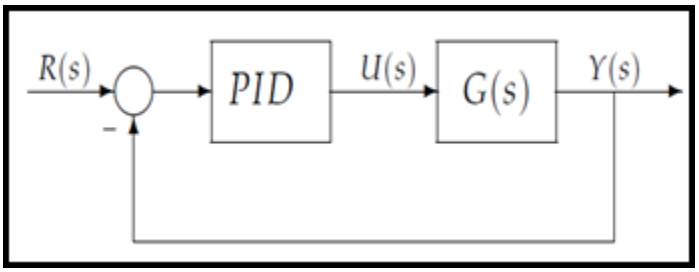

Figure 1. *Block Diagram.*

PID: proportional-integral-derivative control action, this combined action combines the advantages of each of the three individual control actions. The equation of a controller with this combined action is obtained by:

$$u(t) = K_P(t) + \frac{k_p}{T_i}\int_0^t e(\tau)d\tau + k_p T_d \frac{de(t)}{dt}$$

Figure 2. *Proportional-integral-derivative control. And its transfer function results:*

$$C_{PID}(s) = k_p\left(1 + \frac{1}{T_i s} + T_d s\right)$$

Figure 3. *Transfer function.*

The mathematical model that describes the state of the greenhouse microclimate described in Figure 1 consists of a system of two first-order equations that derive from the principle of mass and energy balance.

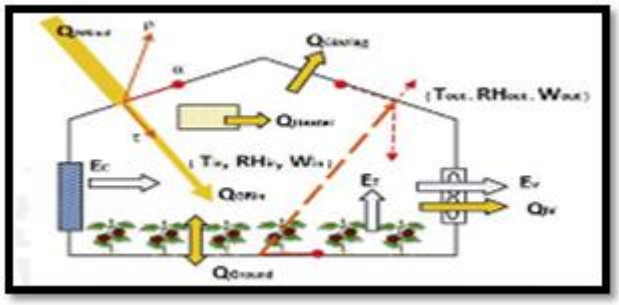

Figure 4. *Representación del flujo de energía.*

The parameters described by the state equations include:

Tin: Air temperature
Win: Absolute humidity
Tf: Soil surface temperature

An optimal regulation result can only be achieved if a regulator structure is chosen that is akin to the regulated system, and that can be adapted to it within certain limits.

This control algorithm works based on error and time, it was designed to correct with the integral part the imbalance or off-set error that generates a proportional control, the control action of a proportional - integral controller.

The parameters of a PID controller were obtained by adjusting Ziegler controllers – Nichols

$$Kp = 6{,}456$$
$$Ti = 40{,}234$$

Controller Type	Proportional Gain, K_c'	Integral Time, τ_i'	Derivative Time, τ_D'
Proportional-only, P	$\frac{1}{K}\left(\frac{t_0}{\tau}\right)^{-1}$	—	—
Proportional-integral, PI	$\frac{0.9}{K}\left(\frac{t_0}{\tau}\right)^{-1}$	$3.33t_0$	—
Proportional-integral-derivative, PID	$\frac{1.2}{K}\left(\frac{t_0}{\tau}\right)^{-1}$	$2.0t_0$	$\frac{1}{2}t_0$

Figure 5. *Representation Ziegler – Nichols.*

2.1 Greenhouse Construction

Recommended height of a greenhouse

There are several experiences in the construction of greenhouses, the one that has given better results is that which allows to reach 3 cubic meters per square meter of surface. Under these conditions a better development of tall crops such as tomatoes and others is achieved. While more interior heating is needed (if needed), the heat will remain longer.

Orientation

Within the characteristics for the orientation of a greenhouse they should allow to receive greater illumination (orientation from east to west), the layout of the land, the prevailing winds and the shape of the greenhouse will condition its orientation and the layout of the crop lines. The cultivation lines should be located north-south to avoid the projection of shadow from one another and that all of them have the same amount of solar radiation as the sun travels throughout the day. On the other hand, in those of shorter length, ventilation can be carried out through windows located in the upper part of the front and bottom, which must also have an opening and closing mechanism.

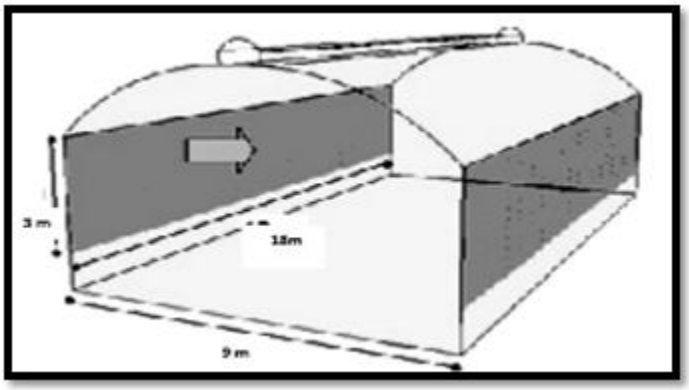

Figure 6*. Greenhouse measures.*

Temperature

It is one of the most important factors in the development of plants. Therefore, one of the main advantages of greenhouses is the possibility of creating the climatic conditions that best suits crops, preventing damage from low temperatures. It is not easy to cool the greenhouse without investing high amounts in facilities and equipment. The structure of the greenhouse can be metallic with angular profiles or round tubes. There is wood alone, or wood and wire. Also of PVC or concrete pipes. The decision of what type of greenhouse will be built will depend on the budget available. But the most used

in galvanized iron. The most commonly used material is low density polyethylene. In commerce they are wide from 6 to 12 meters. It is necessary to consider these measures when designing the structures. Polyethylene. The most used is from 0.15 to 0.20 millimeters thick, with anti UV treatment. Generally, it lasts two seasons and has a greater resistance to adverse climates. [3]

Programmable Logic Controller PLC S7 1200

The S7-1200 controller offers the flexibility and power necessary to control a wide variety of devices for different automation needs. Thanks to its compact design, flexible configuration and extensive set of instructions, the S7-1200 is ideal for controlling a wide variety of applications.

3 RESULTS

Web server configuration of an S7-1200 PLC

To put it into service, you just have to do the following:

- Open PLC settings> Properties
- In Web Server, select Activate web server in the module
- In user administration, create (or not) a user and give them the permissions you want.

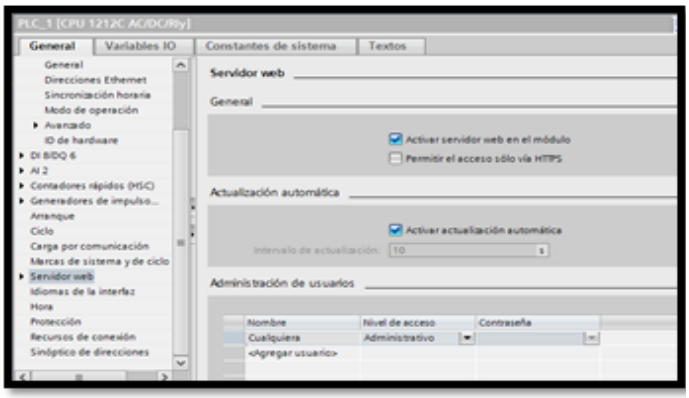

Figure 7. *Web server before configuring a web server.*

On the main screen you will have the basic operation of the PLC, such as putting the S7-1200 automaton in RUN or STOP, in addition to seeing the status of the LEDs or being able to force them to go into intermittent mode to be able to identify them.

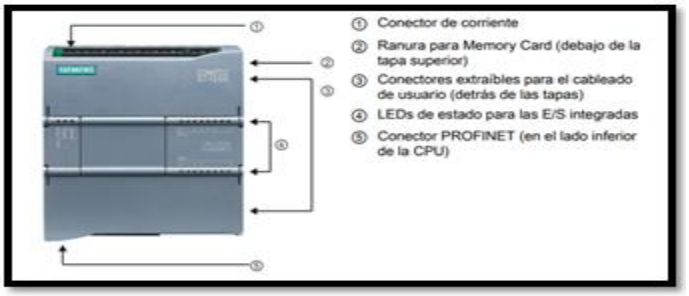

Figure 8*. PLC-s7 1200 Programmable Logic Controller siemens.*

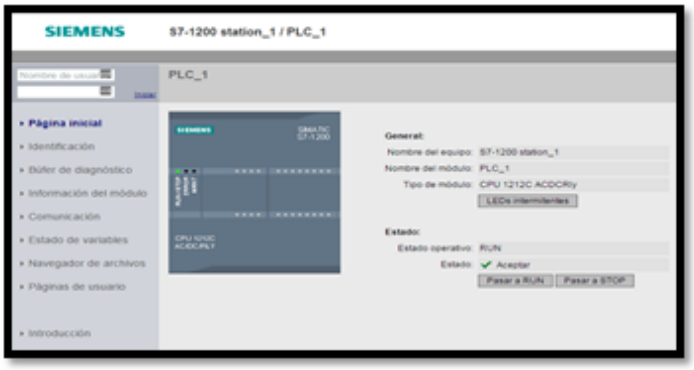

Figure 9. *Main screen of PLC simulation S7-1200.*

Figure 10. *Main screen of the S7-1200 PLC simulation.*

4 CONCLUSIONS

- After having performed the respective tests, it is verified that the objectives set are met, that is, the control and monitoring of the ambient temperature is carried out so that it does not exceed its established value, and for the humidity the control and monitoring of the Humidity of floor.
- The tests that were carried out in this project were established according to the scope proposed.
- The entire system must be installed with their respective protections, such as fuses and breakers.
- In the design for the controller, it was determined by the method of the geometric place of the roots that the plants require a PID controller, because only proportional and integral gain values were obtained, while the derivative was zero.
- If the proportional gain is increased in excess it causes excessive oscillation at the controller output.
- In plants in which their effects are affected, a better system is needed than a SISO (Simple Input Simple Output).
- With the experience acquired, in the development of the thesis, it is recommended to scale with an adaptive intelligent system.
- It is pertinent to perform tests of the controller designed with external disturbances which lead the controller to limit efficiency.
- The design of a MIMO type controller is

recommended, since the plants are of the SISO type due to the cause effect that occurs between them: at higher temperatures, lower relative humidity and vice versa.

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