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Web system for monitoring physical variables in aeroponic crops

Sistema web para el monitoreo de variables físicas en cultivos aeropónicos

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Abstract

This article presents the design, development and simulation of a web system for aeroponic crops that allows the registration of users, crops, nebulization cycles and planting and crop periods. In relation to these, the averages, graphs and reports of physical variables that intervene in the monitoring process are generated, in addition backups are generated and the database is restored, as well as the tracking of the history of the actions performed by the user. The simulation of data collection was carried out using a prototype (electronic circuit) in order to evaluate the functionality of the system.

Aeroponics, Monitoring, Web system, Physical variables

Resumen

En este artículo se presenta el diseño, desarrollo y simulación de un sistema web para cultivos aeropónicos, que permite el registro de usuarios, cultivos, ciclos de nebulización y periodos de siembra y cultivos. En relación a estos se generan los promedios, gráficas y reportes de variables físicas que intervienen en el proceso del monitoreo, además se generan respaldos y se restaura la base de datos, así como el seguimiento del historial de las acciones que realiza el usuario. Se llevó a cabo la simulación de la obtención de datos mediante el uso de un prototipo (circuito electrónico) con el fin de evaluar la funcionalidad del sistema.

Aeroponía, Monitoreo, Sistema web, Variables físicas

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Introduction

Aeroponic cultivation takes place in a closed or semi-closed environment, which presents multiple benefits for crops; the need to supervise and control the monitoring of physical variables (ph, humidity, temperature, electrical conductivity) arises. As well as the automation of the misting process using electrical systems. Currently it is essential to use technology and systems that allow managing the information of these processes from anywhere, generating support and interaction tools for users.

Due to the above, a web system was designed and developed that allows the creation of two types of users (Administrator and Teacher or Student), for the registration of aeroponic crops, planting dates and establishment of optimal intervals of change variables, as well as generation of reports in pdf, excel and graphs (cake / bars) to visualize the censuses obtained every 12 hours, you also have the option to back up data and log user activity within the system.

Methodology

The methodology applied for the development of the system was SCRUM, developing the following phases: planning, implementation, review and launch. Once the phases were applied, a system in a web environment was obtained as a result, which allows to monitor the physical variables (ph, humidity, temperature, electrical conductivity) that are controlled in an aeroponic culture for this particular case, and thus perform nebulization. Below is a describe of what was done in each phase.

– **Planning Phase:** In this, the design of the database (see figure 1), the circuit (see figure 2) and the system interfaces (see figure 3) was carried out.

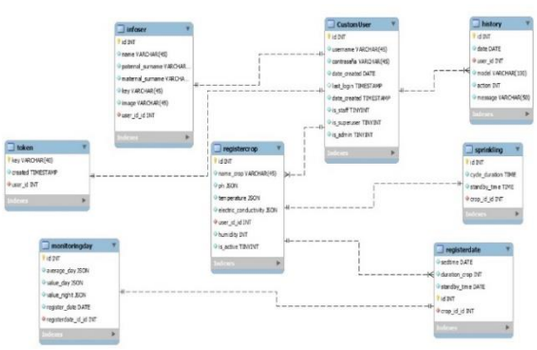

Figure 1 Database
Source: *Own elaboration*

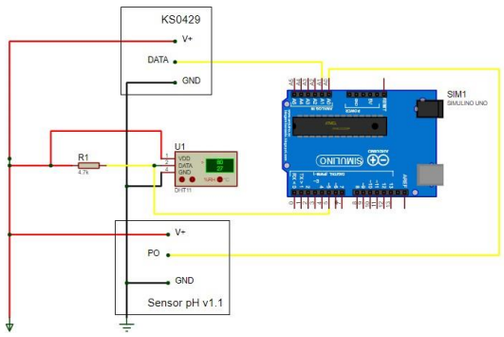

Figure 2 Sensor Circuit (Arduino)
Source: *Own elaboration*

Data collection was also performed (see figure 3) and task lists were established (see table 1) to define the iteration planning (sprint).

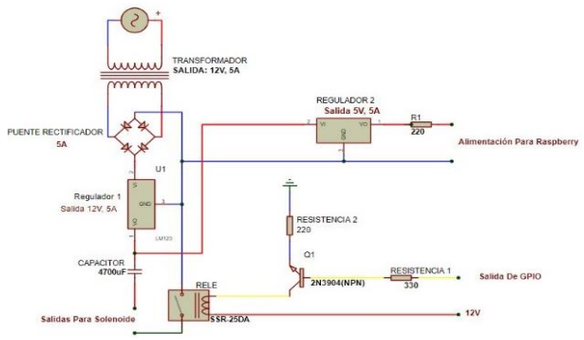

Figure 3 Valve Circuit (Raspberry)
Source: *Own elaboration*

Activities	Chores	Sprint
1	Make user stories	1
2	Design low-fidelity displays of the system.	1
3	Design the administrator and student use cases.	1
4	Design the entity relationship diagram of the database in MySQL Worbench	2
5	Design the module's high-fidelity displays.	2
6	Create modify and display user data in their accounts.	3
7	Register crops with their corresponding variables then activate it with their planting and harvest date.	3
8	Schedule a spray cycle for each crop.	3
9	View daily monitoring.	3
10	Generate reports with the data obtained from the monitoring.	3
11	Make recommendations regarding the analyzes performed (usability tests).	4
12	Develop user manual.	4

Table 1 List of Tasks (BackLog)
Source: *Own elaboration*

– **Implementation Phase:** Once the activities of the planning phase had been carried out, the View Controller Model (MVC) was implemented, thus allowing the identification of the Back End and Front End jobs. Likewise, the configuration of the server in the cloud and local was carried out. Simulation software connected to the Arduino and the Raspberry was used to read the data.

Figure 4 presents an interface for the development of the Front End and Figure 5 shows the Back End of the system. Figure 6 shows the layout of the project folders in the cloud.

Figure 4 Sensor Circuit (Arduino)
Source: *Own elaboration*

Figure 5 Front End Login
Source: *Own elaboration*

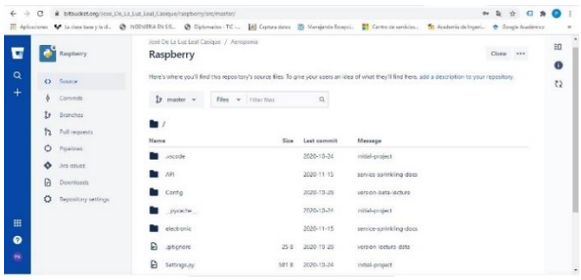

Figure 6 Folders in the cloud.
Source: *Own elaboration*

– **Review Phase:** Software and circuit tests were carried out. The first consisted of evaluating functionality, security through tokens, access points, and response time. Reports were also generated in pdf and Excel formats to validate their download (see figure 7).

Figure 7 Reports
Source: *Own elaboration*

In the circuit tests, data readings and nebulization times were established (figure 8).

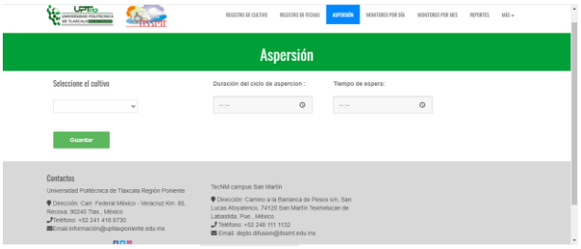

Figure 8 Nebulization Process
Source: *Own elaboration*

– **Launch Phase:** The server was configured, in the cloud to host the System code and the Database. Once the process was finished, an integration validation was carried out. This also included the development of system documentation, such as: technical and user manual.

Discussion of results

Different verifications were carried out in the establishment of the nebulization duration, as well as the data of the physical variables (see figure 9) were census during a period of two months, which allow generating averages, type graphs and pastel bars (see figure 10), reports by day, week and month.

There is a web platform, which has two roles: administrator and students or teacher for interaction with the user. This tool allows the registration of crops, as well as the reading of physical variables (temperature, humidity, pH, electrical conductivity) in which their maximum, optimum and minimum values are established, in addition to assigning the sowing and cultivation dates.

Two relevant functionalities of the platform are the support of monitoring and the history of changes made by users. A relevant feature in terms of security is that the transaction of information from the server to the clients is carried out through the creation and use of tokens (avoiding the loss of data and unwanted access by users outside the system).

Figure 9 Monitoring per month
Source: *Own elaboration*

Figure 10 Pie charts
Source: *Own elaboration*

Conclusions

Cultivating aeroponically reduces the use of space, water and nutrients necessary for a crop, improving its production and quality. The automation of the fogging process supports the crops inside the greenhouse, since the possibility of altering the physical variables is minimized.

Controlling a greenhouse from anywhere, saves time and personnel involved, so this web system automates the following activities: crop registration, optimal intervals of physical variables, sowing and cultivation date, as well as the establishment of spray periods. If there is, a need to view the changes made by a user in the web system, this allows to explore the records or modifications that a user made in the crop fogging processes and present the information from the monitoring of physical variables inside the greenhouse in different formats.

Currently, it was necessary to implement the use of new technological tools such as the use of tokens, to prevent other users from modifying the records without having a username and password in the system, which provided security in the treatment of information in the application.

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