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Web system for automatic irrigation in a greenhouse

Sistema web para el riego automático en un invernadero

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Abstract

The irrigation system in greenhouses is a fundamental aspect in crop production since it is responsible for suplaying water to the plants. The San Sebastián greenhouse is irrigated by drip irrigation, the main characteristic of which is to provide the necessary amount of water and nutrients for the crops. The technological development has impacted irrigation systems in protected agriculture, allowing greenhouses to implement irrigation systems to automatically start and finish the irrigation process. This article describes the project based on a web-based system and a desktop application backed from real-time interface module through automated humidity and temperature sensors, with the objective of improving irrigation productivity and product quality. With the development of the Project, the irrigation automation process, the modules of the web system and the results produced by the system are exhibit. For this project, the Prototypes model was used using the PHP programming language.

Web system, Greenhouse, Automatic irrigation

Resumen

El sistema de riego en los invernaderos es un aspecto fundamental en la producción de cultivos ya que se encarga de llevar el agua a las plantas. El riego con el que cuenta el invernadero San Sebastián es por goteo cuya característica principal es aportar la cantidad de agua necesaria y nutrientes para los cultivos. El desarrollo tecnológico ha impactado en los sistemas de riego en la agricultura protegida, permitiendo que en los invernaderos se puedan implementar sistemas de riego de forma automática para el inicio y fin del proceso de riego. El presente artículo describe el proyecto basado de un sistema web y una aplicación de escritorio que se apoya del módulo de Adquisición de datos utilizando valores en tiempo real de los sensores de humedad y temperatura para el riego de forma automática, esto, con el objetivo del aumento en la productividad y calidad de los productos. Con el desarrollo del proyecto se muestra el proceso de automatización de riego, los módulos del sistema web y los resultados del sistema. Para este proyecto se utilizó el modelo en Prototipos utilizando el lenguaje de programación PHP.

Sistema web, Invernadero, Riego automático

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Introduction

Irrigation automation systems play a fundamental role in greenhouses for irrigating crops, one of the key factors in crop production is water, a basic resource for irrigation, which through the irrigation system provides the supply of water and the necessary nutrients, as well as the amount of water for the plants. The incorporation of automatic irrigation systems has also transformed the form and manner of irrigation in greenhouses, the way of production in agriculture has changed, currently agriculture automates its manual processes which makes production efficient and improves quality of the greenhouse product, an important element of the production system in protected agriculture, because the productive capacity largely depends on it (Fernández, 2012).

Protected agriculture is the production system carried out under various structures and covers, among which greenhouses stand out, whose basic characteristic is protection against the risks inherent in the production of crops in free exposure, their main function is to recreate the optimal and appropriate conditions of radiation, temperature, humidity and carbon dioxide, to generate the reproduction, development and growth of plants, increasing production in quantity, quality and commercial opportunity (Castañeda et al., 2007; Bastida, 2008; Moreno et al., 2011)

The project called "Web System for automatic irrigation in a Greenhouse" was developed with the objective of maintaining optimal irrigation in the plants, controlling the amount of water, reducing time and saving efforts, taking into account the characteristics of the drip irrigation system that It has the "San Sebastián" greenhouse. The results of the project are the web system, the desktop application and the data acquisition module.

For the purposes of this work, only the Data Acquisition module and the desktop application will be briefly mentioned; the detailed operation and design will be presented in another future work. This article contains the problem statement, the data acquisition module, the web system modules, the development methodology, the description of the phases, the results, the acknowledgments and finally the conclusions and bibliographic references.

Problem statement

Crop production under protected agriculture is a modern technique currently used in agricultural production. Irrigation is an essential component of sustained agricultural development. According to Demin (2014), crops need to absorb water from the soil in order to grow and develop. When the moisture content is low, absorption is difficult, which is why it is necessary to water to replenish it and make it available for the crop.

Over the course of eight years, different crops have been planted in the San Sebastián greenhouse and watered using a drip system, which operates up to eight times a day, providing a constant supply of water for the sixteen beds in the greenhouse, where each bed has a valve that is connected to a master valve that allows the flow of water, the process that is followed is manual by opening each valve to later measure the time, either based on your experience or with a predefined measurement (You can be by counting drops or clockwise). Which generates loss of time since the farmer spends time opening and closing valves, counting the drops that fall from the hose per bed, checking the clock and keeping an eye on whether the crops are being watered bed by bed. Another problem is the excess or lack of humidity since the farmer must put his hand into the soil to feel the humidity of the earth and thus determine if more water is required or if he should close the valve according to his experience, putting the harvest in danger, without taking Keep in mind that the needs of crops require a different amount of water, nutrients and depend on the phase in which it is found, whether germination, seedling, plant or in production, therefore the product often does not have quality and economic losses occur.

Data acquisition module

The data acquisition module aims to obtain or generate information on the values of the humidity and ambient temperature variables through electronic devices such as sensors and the Arduino for the operation of the Web system.

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Through an interface it is linked to the web system that shows the values and the results it generates, which means that when requests are received from the server, it is linked in real time to the data acquisition module to start or close the irrigation open or close the valves connected to the master valve automatically.

Development methodology

For the functionality of the web system, the software development model based on Prototypes was used, which aims at the direct participation of the client in the construction of the required software, helping to improve the understanding of what is going to be developed when the requirements are not met or clear and serves as a mechanism to identify and define the software requirements, in addition the prototype evolves through an iterative process (Pressman, 2010, p. 37).

Figure 1 shows the phases: communication, rapid plan, rapid modeling and design, prototype construction, deployment, delivery and feedback.

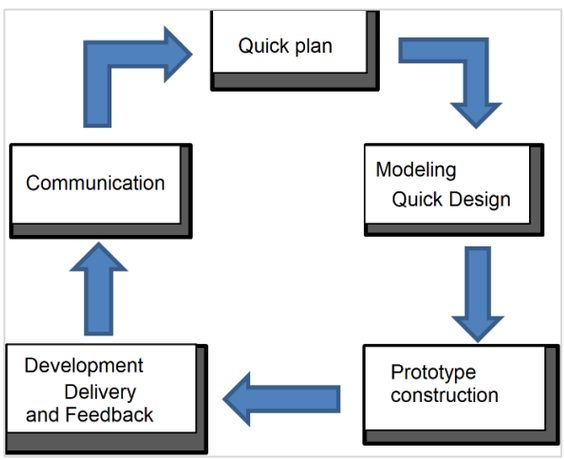

Figure 1. Adapted prototype model
Source: (Pressman, 2010, p. 37)

The phases are described below:

- Communication Phase, in this first stage interviews were carried out with the farmer to find out what the real needs were and the problems presented, for example: identifying manual processes, the irrigation system, manual preparation of fertilizer, fertilization, sowing periods , harvesting, cutting, weather conditions in terms of humidity and temperature, type of crops planted, quantity of crops, information that served to define the requirements, the definition of both general and specific objectives of the software, as well as types of users who will interact with the system.

For the functionality of the web system, three types of users were identified with different roles and privileges for access to the system:

- The Administrator user is the user who has full access to each of the modules, and is responsible for adding information to the system: User data, new crops and new irrigations, greenhouse data, beds and notifications.
- The Farmer user adds data on crops, irrigation period, number of irrigation times, greenhouses, beds and notifications.
- The worker user can only see information about crops, greenhouses and notifications.
- The Quick Plan phase is carried out when the results of the project from the previous stage are accepted, then a representation of the requirements is developed. For this system, the user story technique was used to model the user requirements. Table 1 shows an example of a user story to add the Farmer user type.

User story	
Number: 1	User: Administrator
Story Name: Add User	
Priority: High	Risk: Low
Estimated points: 2	Assigned prototype: 1
Responsible: Oscar Daniel García Cervantes	
Description: As an administrator I want to add a new farmer to the system	
Validation: The administrator can add a new farmer as long as they are logged in within the system	

Table 1 User story: administrator user

- In the Rapid Design Modeling stage, different tasks were carried out such as the design of use cases, graphical user interfaces, two databases were created, the local database and the remote one using MySQL, which is a data management system. Most popular open source relational database based on SQL (Structured Query Language) Structured query language, capable of storing large amounts of data that also uses the client-server model. The server is where the data really resides and to have access, requests are made, this is where the client comes in, that is, requests are sent to the database server to obtain the data that the client requires. The remote database serves as a backup for the local database, if a problem occurs with it, it can be recovered through the backup, in addition the remote database is updated every time there is an internet connection adding the newer data.

In the case of use case models, according to Jacobson (2013) he mentions that "expresses all the ways of using a system to achieve a goal particular for a user. As an example, a use case model is shown to Log in to the system, first you have to Validate data using a username and password. See figure 2.

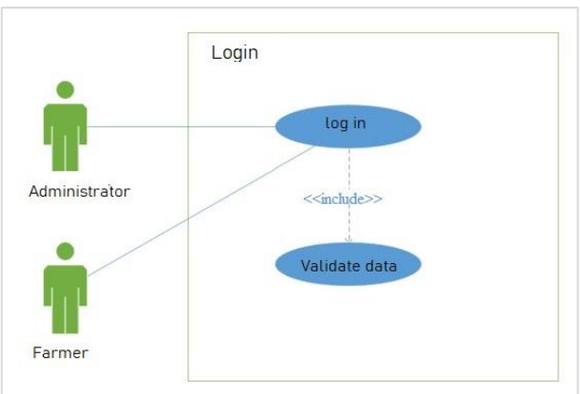

Figure 2 Login use case

- Prototype construction stage, in this stage the user, crop and greenhouse modules were developed for coding, the PHP (Hypertext Pre-Processor) programming language was used, that is, Hypertext Pre-Processor. It is an open source, general-purpose programming language for web development that runs on the server side.

- In relation to the operation of the web system, it is linked to the Data Acquisition module through the Water button to obtain temperature and humidity measurements.

- The last phase of deployment, delivery and feedback of the system, the functionality of the web system was reviewed through different types of tests, reviews were carried out by the farmer and they were adapted to the requested requirements.

Results

Next the results of the modules: users, crops and greenhouses are described below:

- Access to the system, to enter the system a username and password are required. See Figure 3.

Figure 3 System access screen

- Main Screen, this screen shows the main view of the web system, the options menu, the current system data obtained from the data acquisition module with the humidity value using the water button, see figure 4.

Figure 4 Main menu

- One of the main functions of the web system is irrigation, and this is where the farmer makes the request for the valves to be activated automatically and start irrigation. The main screen shows the water button, pressing the button links to the Data Acquisition module to obtain humidity, this is displayed in real time in the system, the duration of irrigation will depend on the times assigned in the system by the farmer depending on the type of crop that is planted at that time, the web system is configured to send and receive notifications for the start or closure of irrigation based on the humidity sensor value. See figure 5.

Figure 5 Water button

- When you press the water button, the server displays a screen where it shows the question to the Farmer, do you want to start irrigation? The decision-making by the farmer is essential, whether or not the start of irrigation in the greenhouse will depend on him. See figure 6.

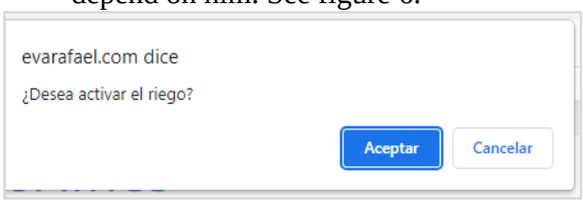

Figure 6 Accept button to start irrigation

Clicking on the Accept button starts the irrigation process, see figure 7.

Figure 7 Water button

- User module

This screen shows the users registered in the system using a board. You can also search for a user by name by typing one letter or more and clicking the Search button. See figure 8.

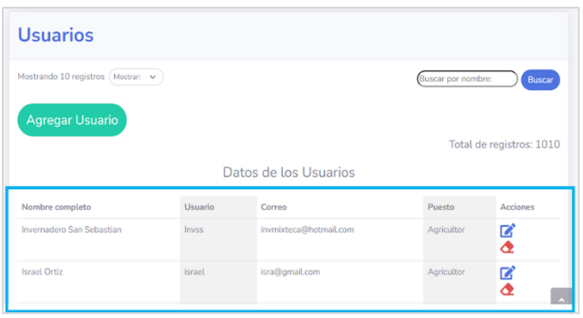

Figure 8 Registered users of the user module

- User registration below is the form for user registration, with the following fields: Full name, username, password, confirm password, user position and email, there are mandatory fields that are marked with an asterisk. See figure 9.

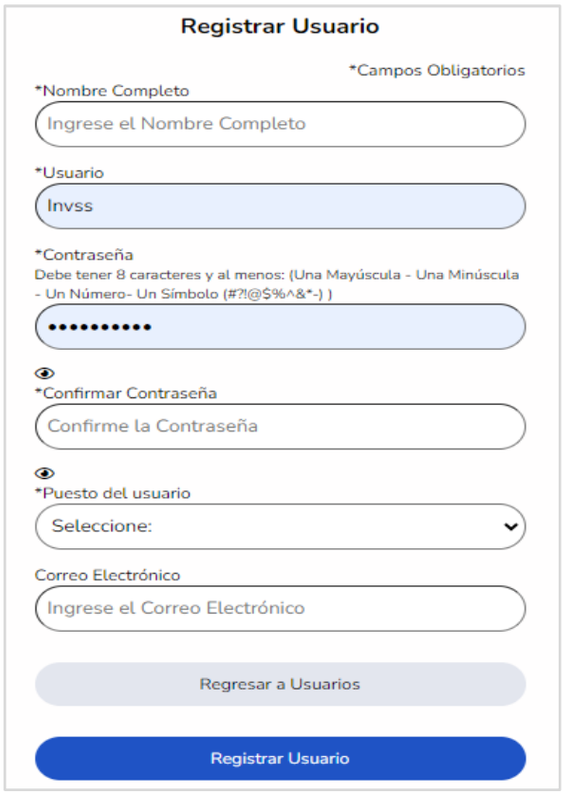

Figure 9 User registration

- Crop module

Figure 10 shows the crop module screen with the corresponding information for each of them. You can search for the crop name by writing one letter or more and clicking on the Search button.

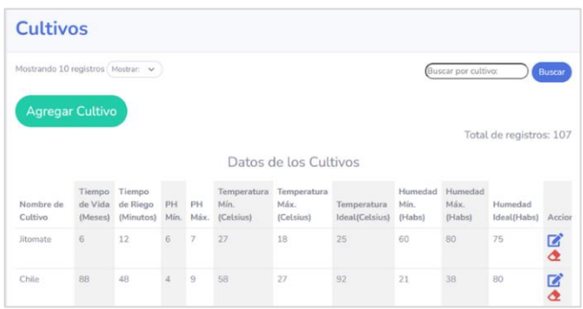

Figure 10 Crop module

- Crop registration

This screen shows the fields to register a crop to the system. There are mandatory fields that are marked with an asterisk, once the fields are filled out, press the Register Crop button to save the new crop. See figure 11.

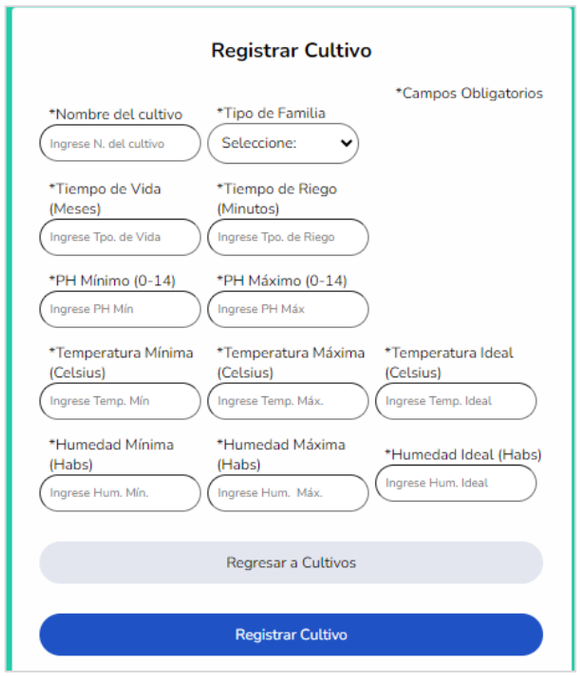

Figure 11 Crop record

- Greenhouse module

In figure 12 you can see the bed data, the number of beds and the crop found in each bed or group of beds in the greenhouse. It also has two options that allow you to edit the bed data and eliminate the number of beds. beds as required by the farmer, you can also search for a crop by name by writing one letter or more and clicking on the Search button.

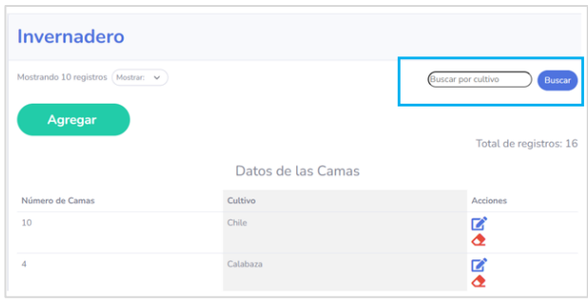

Figure 12 Greenhouse module

- Add beds

The Add button allows you to add a new bed record to the greenhouse module. In the form there are mandatory fields marked with an asterisk. Once the fields are filled out, press the Register Bed button to save the new record. See figure 13.

Figure 13 Register beds

Acknowledgments

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The collaboration and dedication of the authors of the article, professors and students who participated responsibly in the research until the results presented were achieved are appreciated; The objective of this research is to be able to disseminate the findings to the academic community and the general public about the work carried out at the Institution.

Conclusions

The web system for automatic irrigation in a Greenhouse was developed with the objective of maintaining optimal irrigation in the plants, controlling the amount of water, reducing time and saving efforts as a low-cost alternative for farmers, crops and harvests under Greenhouses. Irrigation in greenhouses is a fundamental part for the development of the plant, the "San Sebastián" greenhouse has a drip irrigation system for the distribution and irrigation of crops, the main characteristic of which is that it provides the necessary amount of water and nutrients to the crops.

The system allows irrigation to be programmed, records the number of irrigation times, validates the times assigned to each irrigation, sends notifications of the start and closure of irrigation, relying on the Data Acquisition module to obtain the sensor value in real time, in addition to the modules that the web system has for proper functioning.

This project secures the foundations so that new functionalities can be added such as data analysis and the application of artificial intelligence in the future.

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