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Title: Automatic irrigation of hydroponic lettuce cultivation with IoT

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PRESENTATION CONTENT

Introduction

The use of water is defined as the application of water to an activity where consumption occurs. This consumption is understood as the difference between the volume supplied and the volume discharged, and it is referred to as consumptive use. There are other uses that do not consume water, such as the generation of electrical energy using water stored in dams; these are called non-consumptive uses (CONAGUA, 2022).

Water scarcity in Mexico has increased in recent years. Along with population growth, food consumption has also risen, making it necessary to grow vegetables efficiently, eliminating water waste, and carefully managing the water, sunlight, temperature, and soil requirements for each vegetable species.

At the Fidel Velázquez Technological University, located in the municipality of Nicolás Romero, State of Mexico, hydroponic lettuce cultivation is required for educational purposes within the Environmental Technology program.

For this specific project, hydroponic lettuce cultivation was chosen because of its short harvest time. Lettuce requires little sunlight, and while it is sensitive to humidity, which can promote fungal growth, it has a lower risk of pests when grown for 50 to 70 days, provided its specific needs are met. This type of cultivation is not affected by meteorological phenomena, allowing for off-season production and reducing water consumption by enabling recycling, which also helps lower environmental pollution.

The main beneficiaries of this project are the university, teachers, students, and society as a whole. The implementation of automatic irrigation will solve the problem of inefficient water use, reduce costs, and contribute to more sustainable and efficient agricultural production by offering a technical and systematic solution.

Methodology

The study follows a quantitative and experimental approach, as the required environmental variables include ambient temperature (°C) in the environment where the sample of 10 lettuce units is grown. This temperature must be monitored to maintain optimal growing conditions. Additionally, the relative humidity percentage is controlled to ensure proper levels.

Data collection was carried out through sensors measuring temperature, humidity, substrate moisture, pH, the automated irrigation controller, and water and energy consumption meters.

Variables related to the growing medium include substrate moisture percentage, which measures the water content in the hydroponic substrate to ensure the proper amount of water is provided. The pH level of the nutrients indicates the optimal range for nutrient absorption.

Regarding the irrigation system variables, they include:

- Irrigation frequency: Determines how many times per day the irrigation system activates.
- Irrigation duration: Measured in minutes, it indicates the length of each irrigation cycle.
- Water volume applied: Measured in liters, it indicates the total amount of water applied during each irrigation cycle.

Results

The automated irrigation system is designed as a mobile tool, allowing students in the Environmental Technology program to control and monitor water usage for the lettuce crop. The primary goal is to optimize water use, and the system achieves this by tracking soil temperature and humidity.

The data collected is sent to the ThingSpeak platform, where it is analyzed in real-time, represented graphically, and made available on mobile devices. This enables informed decision-making when cultivating lettuce or other vegetables. Figure 1 illustrates the application's login screen, which includes fields for entering a username (email) and password, as well as buttons for logging in and creating a new account.

References

The references utilized for this study were selected based on their relevance to the research on automated hydroponic irrigation systems and water management. They include fundamental resources and specific studies that provided crucial support and background information for the project.

Support:

1. **CONAGUA. (October 2022).** *Water Statistics in Mexico 2021*. This source was instrumental in providing a comprehensive overview of water usage and scarcity issues in Mexico. The data and insights from this report were foundational in understanding the broader context of water conservation and the necessity for efficient irrigation systems.
2. **Hernández de Lira, V., Domínguez Báez, C., García González, S., & López Cruz, B. D. J. (2018).** *Feasibility analysis of a hydroponic cultivation system in Casa del Sol*. This study offered valuable insights into the practical aspects and challenges of implementing hydroponic systems. It provided a comparative analysis of different hydroponic setups, which informed the design and methodology of the current project.
3. **Marquez Fernandez, H. (2020).** *What is hydroponics and how does hydroponics work? - Hydroponic plantations*. This resource was essential for understanding the basic principles of hydroponics and the mechanisms behind it. It served as a starting point for the technical aspects of hydroponic cultivation used in the research.
4. **Marin Mendoza, D. W., & Romay Ossio, M. A. (2018).** *Design and implementation of an automatic irrigation system for the crops of the UMSA Faculty of Agronomy in Cota Cota (Doctoral dissertation)*. This dissertation provided a detailed example of an automated irrigation system design, offering valuable insights into the implementation and challenges of such systems. The methodologies and design principles discussed were adapted and applied to the current hydroponic irrigation system project.

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