Device for collecting and monitoring temperature and humidity with cloud storage for agricultural purposes

Dispositivo de recogida y control de la temperatura y la humedad con almacenamiento en la nube para fines agrícolas

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Abstract

The integration of technology in different areas of research undoubtedly represents one of the best practices that human beings can do, areas that help the growth of sustainability such as the use of technology in agriculture, represent today an area of opportunity for technological development not only in urban but also in rural regions; the present research project aims to develop a device that helps in the collection and monitoring of agroclimatic variables such as temperature and humidity using real-time storage technology in the cloud, this will help protected agriculture to maintain and keep track of these variables to facilitate decision making in terms of saving resources and get better crops based on really relevant information, the research methodology is considered quantitative with an applied technology approach, what will be measured is the impact of the device used in the greenhouse of the technological university of Poanas as a first stage. The implementation of this technology in the rural area of Poanas in Durango, is undoubtedly a milestone in the employability of technology in improving the sustainability of local agricultural products.

IoT, technology, Protected agriculture

Resumen

La integración de la tecnología en los diferentes ámbitos de la investigación sin duda representa una de las mejores prácticas que el ser humano puede hacer, áreas que ayuden al crecimiento de la sustentabilidad como lo es el uso de la tecnología en la agricultura, representan hoy en día un área de oportunidad para el desarrollo tecnológico en regiones no solo urbanas si no rurales; el presente proyecto de investigación tiene como objetivo desarrollar un dispositivo que auxilie en la recolección y monitoreo de variables agroclimáticas como lo es la temperatura y humedad haciendo uso de la tecnología de almacenamiento en tiempo real en la nube, esto ayudará a la agricultura protegida a mantener y llevar un control de dichas variables que faciliten la toma de decisiones en cuanto al ahorro de recursos y obtener mejores cosechas basadas en información realmente relevante, la metodología de investigación se considera cuantitativa con un enfoque de tecnología aplicada, lo que se medirá es el impacto de dicho dispositivo usado en el invernadero de la universidad tecnológica de Poanas como primera etapa. La implementación de esta tecnología en el área rural de Poanas en Durango, en sin duda un hito en la empleabilidad de tecnología en la mejora de la sustentabilidad de los productos agrícolas locales.

IoT, Tecnología, Agricultura protegida

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Introduction

Introducing Information and Communication Technologies (ICT) in agriculture allows making it more efficient, reducing costs and introducing certainty in decisions. Similarly, using ICT based on the use of digital platforms, Big Data, Analytics, IoT, contributes to the rational use of resources, increased productivity and improved profitability. (Rambauth, 2022, pp 34).

The implementation of information and communication technologies (ICT) has become an excellent tool that allows companies to generate added value to operational activities, seeking to offer business advantages to achieve consolidation in a global market. Similarly, it can be seen how companies have opted for innovation, which is a set of tools that allow the correct application of knowledge management (Jiménez and Rodríguez, 2019, pp 85).

Due to globalization, companies in general have more demands in terms of competitiveness, seeking to generate products and services that are of excellent quality for the final consumer. The present document consists of designing and implementing a device that can collect and monitor climatic data of humidity and temperature which will be stored in the cloud in real time, which will allow the user through a connection to the database to review the information obtained and make decisions leading to detailed solutions to a specific situation, allowing to generate added value to operational activities.

Nowadays, agricultura and technology must come together to work as a team, according to Chanchí, Ospina & Saba (2022) suggest that "one of the topics that has had great diffusion in the last decade thanks to the advantages of monitoring and automation of different processes in various application contexts is the Internet of Things (IoT)" (p 258), which will support the monitoring of climatological variables of interest in various crops for different users.

Technology represents an impact on human society, however, these impacts are not homogeneous, sectors and social classes differ and are affected in different aspects. The use of technology in society awakens the interest of scientific research applied to different sectors and on different aspects (Foladori, 2022).

Therefore, the following article seeks to collect some of the agroclimatic variables that allow users to make their agricultural processes more efficient, seeking sustainability and environmental protection.

The hypothesis to be tested is: H1: The use of a device that monitors humidity and temperature variables reinforces and facilitates decision-making aimed at sustainability.

H0: The use of a device that monitors humidity and temperature variables does not reinforce or facilitate decision-making aimed at sustainability.

The present research work contains the development methodology of the device, as well as the research approach used, the justification, objectives to be met, results, conclusions, recommendations and bibliographical references.

Development of the device

In the globalized world in which we find ourselves, it is of vital importance to share knowledge with the various business partners, according to Tovar, Solorzano, Badillo & Rodríguez (2019) suggests that "there is currently a strong growth in the automation of agricultural work due to the technological evolution and population expansion of the planet" (p. 88), hence the importance of sharing knowledge.

The necessary requirements for the implementation of the device are defined, which according to consists of a 20 x 4 LCD screen, with I^2C module to display the data of: Temperature, Humidity, Date and Time, DS3231 which has I^2C communication to obtain the date and time previously set, the DHT11 sensor which is digital and from it the humidity and temperature data are obtained; the nodemcu, which is a microcontroller that has integrated wifi and controls the aforementioned devices and sends the data to the cloud hosted in Firebase.

According to Arellano Díaz, (2022) "the LCD display has 20 columns and 4 rows, plus it has led lighting and contrast adjustment for correct data display" (p. 11), of humidity, temperature, date and time and it also has I2C module.

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The DHT11 temperature and humidity sensor has an operating voltage of 3 to 5 volts and is digital, which makes it optimal for connection to the nodemcu microcontroller; it has a measuring range of 0 to 50°C and relative humidity from 20 to 90%.(Feresu, Z. ,2022)

According to Tarun Singh and Ritula Thakur (2019) "the DS3231 clock module is device that provides real time (date and time) that integrates a crystal with temperature compensation, so it ensures long-term accuracy"(p. 364), as long as the battery it uses is in optimal condition, which communicates with I^2C protocol.

According to Satria(2019) "the nodemcu ESP32 is a controller device of electronic circuits or hardware to perform particular functions according to the application program developed, it has wifi connection to be able to perform programs focused on internet of things (IoT)."(p. 134)

According to Jiménez-Naharro, R.. (2017) "the use of the I^2C protocol helps to make the wiring less, being that, by the same pair of wires, several devices can be connected."(p. 2)

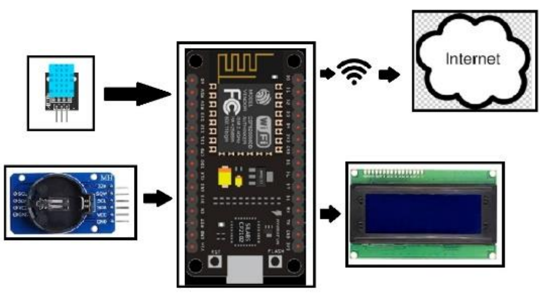

Figure 1 Block diagram.
Source: Own elaboration

Figure 1 shows the block diagram used for the implementation of the device, showing the inputs and outputs of the elements that make it up.

The place of study will be the greenhouse of the Technological University of Poanas, which at the present date of this document has as sowing tomato saladette XXL, has a size of 50 m x 40 m, in Figure 2 you can see the greenhouse.

Figure 2 Greenhouse at the Universidad Tecnológica de Poanas

Figure 3 shows the device in the greenhouse area and how the connections are made to access the monitored data in real time.

Figure 3 Prototype Implementation in Work Area

Figure 4 Temperature and Humidity Measurement

Figure 4 shows the measurement of temperature and humidity with the DHT11 sensor, with a measurement accuracy of +-2° C, the result is displayed on the LCD screen informing in real time the data captured at that precise moment of the measurement.

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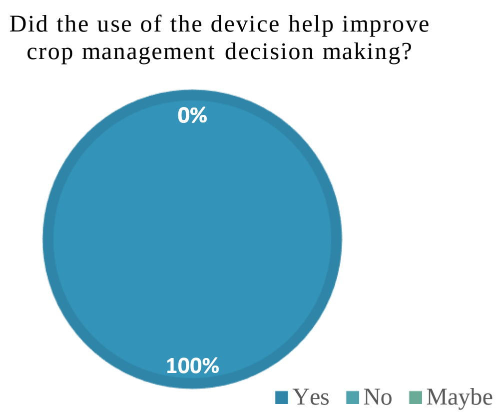
Results

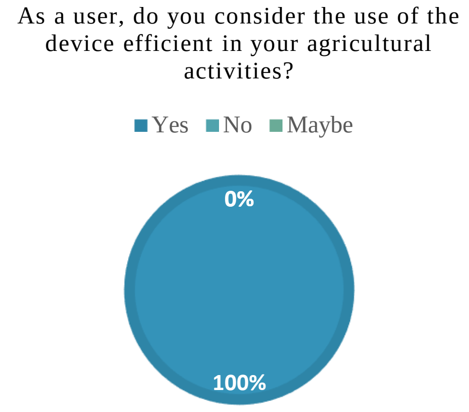
The Smart agriculture using IOT has been experimentally proven to work satisfactorily by monitoring the values of humidity and temperatures successfully. Throught the internet control the motor in the field. It also stores the sensor parameters in the timely manner. This will help the user to analyze the conditions of various parameters in the field anytime anywhere. Then control or maintain the parameters of field properly. Finally it concludes that automatic irrigation system is more efficient than scheduled irrigation process. (Jyostsna, Aala, Srilatha, Vijay y Bharath, 2018, pp 3028)

The device was implemented in the greenhouse of the Technological University of Poanas, where they currently have an XXL saladette tomato planting, the sample selected for testing the alternative hypothesis that indicates H1: The use of a device that monitors humidity and temperature variables reinforces and facilitates decision making aimed at sustainability, was considered for convenience, considering the aspects of sustainable and protected agriculture in this case the greenhouse, the following results were reached.



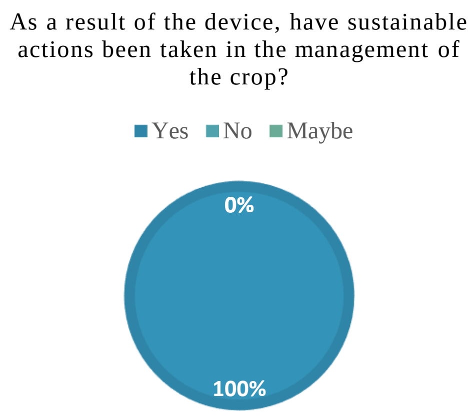
Graphic 1 Improved Decision Making

Graph 1 shows that the device greatly helped to improve decision making in terms of crop management, from controlling humidity, responsible use of water and plant health to proper soil use.



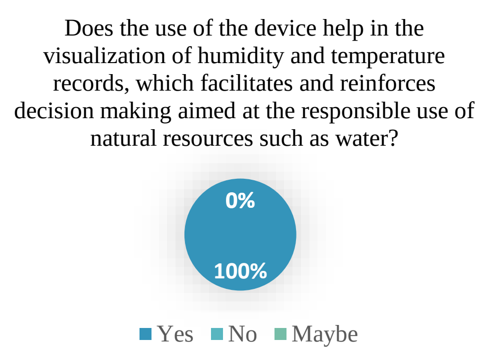
Graphic 2 Device Efficiency in Agricultural Activities

According to the opinion of the user participating in the research, as shown in Figure 2, the use of the device makes agricultural activities inside the greenhouse more efficient, since the values are stored in a database in real time in the cloud, which will allow consultation from anywhere without the need to go physically.



Graphic 3 Sustainable Actions in Crop Management

According to Graph 3, the proper use of the device has generated benefits in terms of sustainable actions in crop management, such as the responsible use of water.



Graphic 4 Device Use in Data Visualization

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Graph 4 shows that the visualization of the humidity and temperature records helps the user to make decisions on the responsible use of natural resources, having a good production of XXL saladette tomato in the protected cultivation area of the institution.

According to the data analyzed with the instrument implemented in the expert's opinion, it can be said that the alternative hypothesis is accepted indicating that the use of the device will reinforce and facilitate decision making aimed at sustainability activities starting with the responsible use of water.

Conclusions

Undoubtedly one of the challenges for Mexico and the world is to cover the food supply, according to Baldivia and Ruiz (2017) suggests that "between 1980 and 2015 the available land per capita decreased 31 percent, this means that in the future to increase production farmers should focus on improving crop yields" (p. 2079), therefore it is of utmost importance to acquire technological tools that support decision making for farmers.

The consequences of climate change, such as the increase in temperature, CO2 and the variation of soil acidity, agriculture is one of the areas that has been affected. As a result, low productivity is seen, as well as a decrease in the quality of most crops. (Ossa Duque, 2017, pp 51).

The evolution of the field and the activities carried out allow us to affirm that the agricultural sector is an area of great opportunity for the implementation of IoT in the coming years. The implementation of IoT solutions allows to follow the modernization based on the demand that the agricultural sector presents. It is expected that in the following years the use of technology in this sector will allow a 70% increase in global food production, this for the year 2050 allows generating an encouraging impact since it is estimated a population of 9.5 billion inhabitants in the world. (Tovar Soto, et al., 2019). The implementation of the device has the following advantages: the temperature and humidity can be monitored in real time without being physically in the protected area, in addition to the fact that the device displays the aforementioned values.

In the future, we intend to implement the development of a mobile application that will allow monitoring of the data collected by the device from any location.

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