Monitoring of agri-environmental variables in a coffee lot to evaluate its behavior through data analytics and IoT

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Abstract

In this project we apply descriptive and diagnostic analysis focused on precision agriculture, in order to analyze the behavior of certain environmental variables in the planting and cultivation of coffee and determine certain conditions or behaviors that could affect the production of the crop and therefore its final quality. In addition, aspects such as the appearance of pests and diseases, humidity and control of environmental and soil temperature can be controlled, being able to establish corrective measures or actions to take if the permitted parameters are exceeded.

Introduction

Precision agriculture has become one of the areas where Wireless Sensor Networks (WSN) have been widely and successfully implemented. This type of technology favors the reduction of water consumption and the use of pesticides and fertilizers, favoring the preservation of the ecosystem. Additionally, it allows generating alerts on the arrival of frost, floods, fires, variation in the behavior of environmental variables, etc. Precision agriculture encompasses multiple practices related to the management of crops and crops, trees, flowers and plants, livestock, etc.

Overall Objective

Implement a wireless network of sensors that allows the collection and sending of data on a coffee crop to an IoT platform where said information is received and processed and subsequently descriptive and diagnostic analytics techniques are applied to evaluate the information and determine the possible variants to be used. the parameters initially established.

Specific Objectives

- Determine the main physical environmental variables related to the cultivation of coffee.
- Establish how these variables affect or not the quality and production of the grain.
- Design, configuration and implementation of the wireless sensor network (WSN).
- Configure the sensors to take periodic measurements of agro-environmental variables every 10 minutes in the coffee crop.
- Transmit the information generated by the sensors to IoT platforms in the cloud, to link the devices and store the results.
- Analyze the measurements received by applying descriptive and diagnostic analytical techniques to evaluate the reliability of said data and be able to make decisions or make corrections about the crop's production processes.

Research Methodology

The development of the project is framed within the type of experimental applied research, in fig. 1 we can visualize its stages:

- Design, configuration and implementation of the wireless sensor network (WSN)
- Data collection Through sensor nodes
- Sending data to the IoT platforms
- Data Storage on TAGOIO (IoT Platform)
- Data transformation and application of descriptive and diagnostic techniques for analysis.

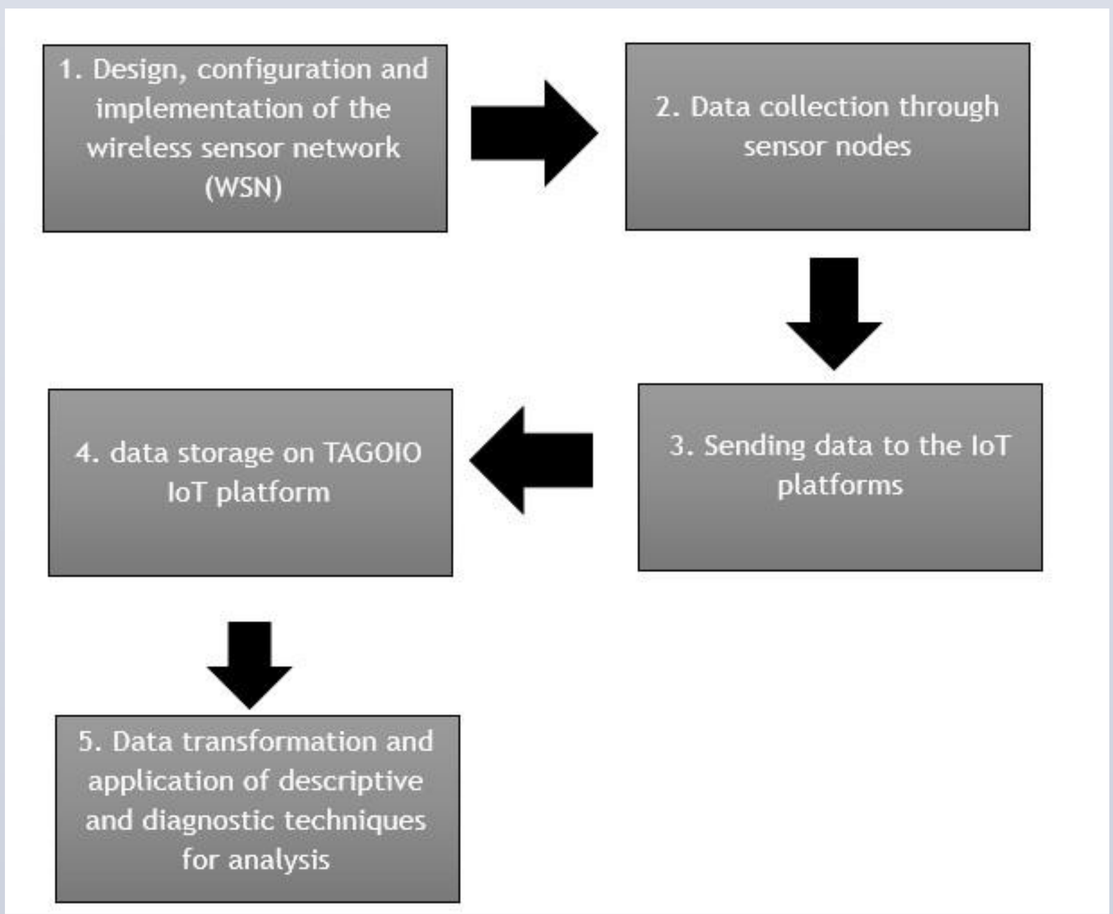

Fig. 1 Methodology used for the development of the Project

Expected Results

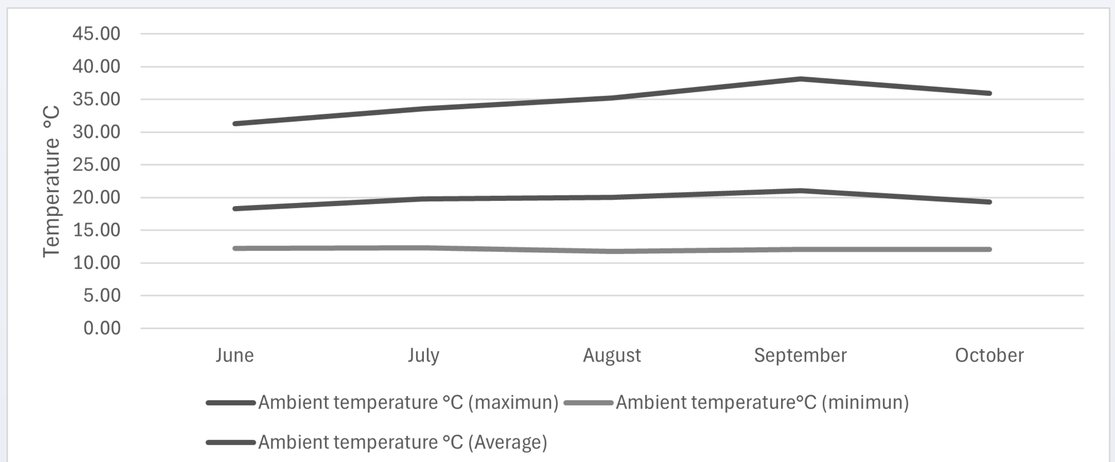

Fig. 2 Variation of environmental temperature in the Las Acacias farm (Source: Own)

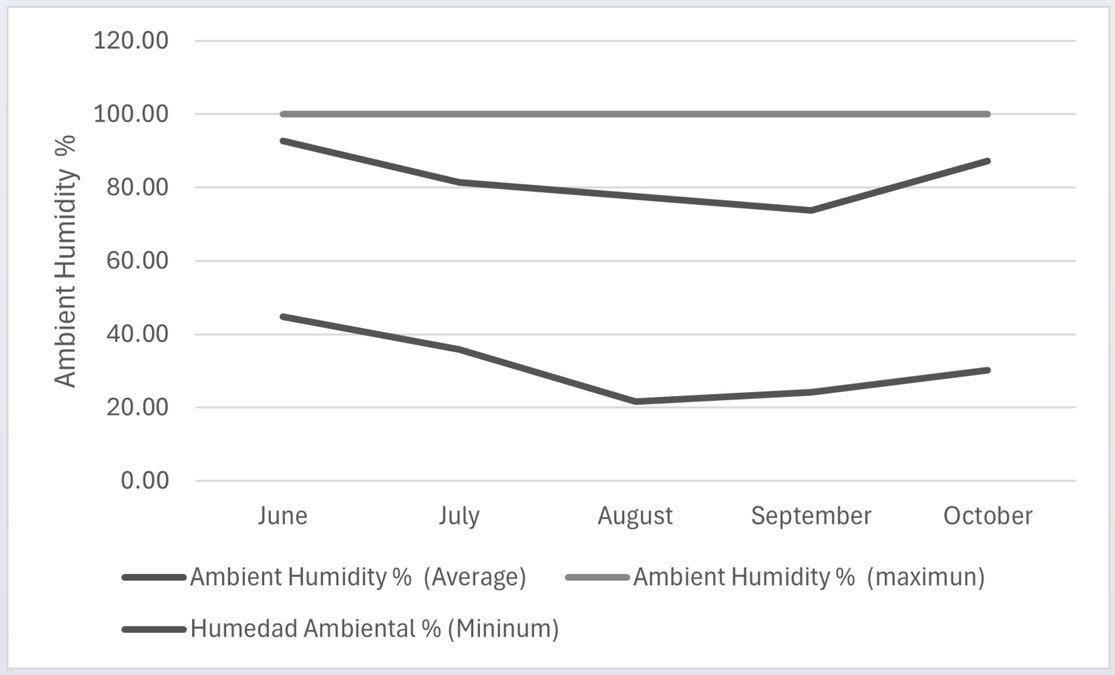

Fig. 3 Variation of ambient humidity in the Las Acacias farm (Source: Own)

According to the data in Figures 2 and 3, the ambient temperature reveals that the highest peak occurs in September with 38.1°C, while the minimum temperatures remain constant between 11.8°C and 12.3°C. . This increase in maximum temperature, especially during the end of summer, can generate heat stress conditions in coffee trees. This phenomenon affects key processes such as photosynthesis and coffee metabolism, reducing the plant's ability to fix carbon and produce essential sugars for fruit development. Furthermore, the wide thermal range between maximum and minimum temperatures can aggravate the impact of thermal stress by intensifying daily fluctuations in environmental conditions, adding physiological pressure on the crop.

On the other hand, the minimum relative humidity drops abruptly in August, reaching just 21.7%. This drastic reduction indicates an unfavorable dry period for flowering, since water deficit can cause flowers to drop and affect fruit setting, which in turn reduces productivity. The high maximum relative humidity (100% during all months) suggests a humid environment that, although it may be beneficial in reducing water stress, significantly increases the risk of fungal diseases such as coffee rust (Hemileia vastatrix).

Conclusions

- The integrated analysis of climatic and soil conditions in Salento, Quindío, indicates that extreme variations in temperature and humidity, together with water deficit in August and September, have a significant impact on coffee development and productivity.
- High temperatures and low relative humidity can induce water and thermal stress, negatively affecting flowering, fruiting and grain quality.
- To mitigate these effects, it is recommended to implement agronomic practices adapted to the local climate, such as the use of shade, controlled irrigation and monitoring of soil electrical conductivity. These strategies will help maintain the sustainability and productivity of the crop under variable climatic conditions.

References

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