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FRUIT PRODUCTION MAPPING SYSTEM: TESTS AND TECHNOLOGICAL ADJUSTMENTS

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ABSTRACT

We address the importance of Brazilian agriculture as a fundamental sector for the country's economic growth. With a significant share of the national GDP, agriculture requires technological advances to increase crop production in a sustainable way. Precision agriculture (PA) emerges as a solution, treating cultivation areas in an individualized way with advanced technologies, such as harvesters with autopilot, sensors, drones and GNSS receivers.

It focuses on the development of an embedded system to map the productivity of fruit plant crops. We used a device with GPS, RFID and memory card storage, controlled by an ESP32 microcontroller and programmed into the Arduino IDE. The system tracks the manual harvesting of fruits, recording location and quantity data.

We successfully tested the system on the bench, with the integration of the Arduino IDE hardware and code. The project aims to collect data for geostatistical analysis, optimizing the management of inputs and human resources. We observed challenges in the Arduino IDE interface and charging system, which deserve future attention.

We hope that this work will contribute to increasing productivity and reducing costs in agriculture, promoting a more efficient management of cultivated areas.

Keywords: Agriculture. Development. Technology.

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INTRODUCTION

Brazilian agriculture is one of the most profitable and economically consistent sectors at the moment and that contributes the most to the growth of the national Gross Domestic Product (GDP) with a share of approximately 25.5% of the amount in 2022 (CEPEA, n.d.). With such financial dependence comes the need for technological advances that make it possible to increase crop production in a sustainable way, this agricultural transformation opens up an opportunity for a structure based on research, development and innovation.

The use of precision agriculture (PA) has been expanding and solidifying in agribusiness, it aims to value the production chains and offer the best products in addition to the preservation of natural resources through the use of advanced technologies (MEDINA, n.d.). This practice reconciles the management of large cultivation areas considering the spatial variability of crops, that is, they are treated as if they were small crops being analyzed separately and with the amount of this data helps to identify the necessary actions for the soil, assisting in the management of agricultural inputs punctually.

PA is a sum of various technologies that together convey a way to evaluate, quantify and map the soil (INAMASU; BERNARDI, 2014). Some examples of a PA are harvesters with autopilot, sensors, drones, GNSS (Global Navigation Satellite System) receivers, among many others (MOLIN; ADAM; COLAÇO, 2015).

Embedded electronics are already widespread in the daily routine of Brazilian agriculture, bringing customized solutions that combine hardware and programs dedicated to data acquisition, processing, storage and communication (SOUSA; LEE; INAMASU, 2014). Therefore, this present work aims to develop an embedded system to make a productivity map of a fruit plant crop.

MATERIALS AND METHODS

RESEARCH OPERATING PROCEDURE

The data collection process for an orchard area will be done through an embedded system with georeferencing. The electronic device has a Global Position System (GPS) signal receiver, which collects geographic coordinates, a Radio-Frequency Identification (RFID) reader and a data storage system on a micro SD memory card. These modules are interconnected by means of a Printed Circuit Board (PCB) and are controlled through the

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ESP32 microcontroller, in which the software that implements reading and storing the data is done through the Arduino IDE.

EXPERIMENTAL PROCEDURE FOR DATA COLLECTION

The device developed has an identification number that will be attached to the bags used by employees who manually harvest the fruits from the trees. The harvested fruits are unloaded in boxes that also have identification from an RFID card, with their respective number. At the time of unloading by the employee, the RFID module of the equipment present in the bag receives the signal from the RFID card attached to the box. Thus, a record in a text file stores the data on the micro SD memory card, allowing the identification of the box number and the number of downloads made on it. The GPS receiver also provides reading of the employee's position (latitude and longitude) at set time intervals, as well as the current date and time at the time of collection.

SYSTEM POWER AUTONOMY

The prototype will be powered by two rechargeable Li-Ion Li-Ion batteries, model 18650 of 4.2V, with a charging capacity of 9800mAh each, connected in parallel for greater autonomy, since this way the energy capacities are added. However, there is a need to adjust the output voltage of the battery since not all modules present depend on 3.3V power supply, for this purpose a 1N4007 diode was added, which in addition to providing the necessary 0.7V voltage drop, also helps to protect the PCB circuit avoiding reverse currents in possible polarity exchange in the power supply.

TP4056 modules were added, responsible for regulating battery charging, avoiding overcurrent or charges above the nominal capacity of the batteries. This protection is essential, since batteries are sensitive to misuse and also correspond to the highest financial cost of the system.

A schematic of the equipment's circuit was developed in ECAD (Electronic Computer-Aided Design) software, this is a dedicated system for designing electronic structures, and is shown in Figure 1.

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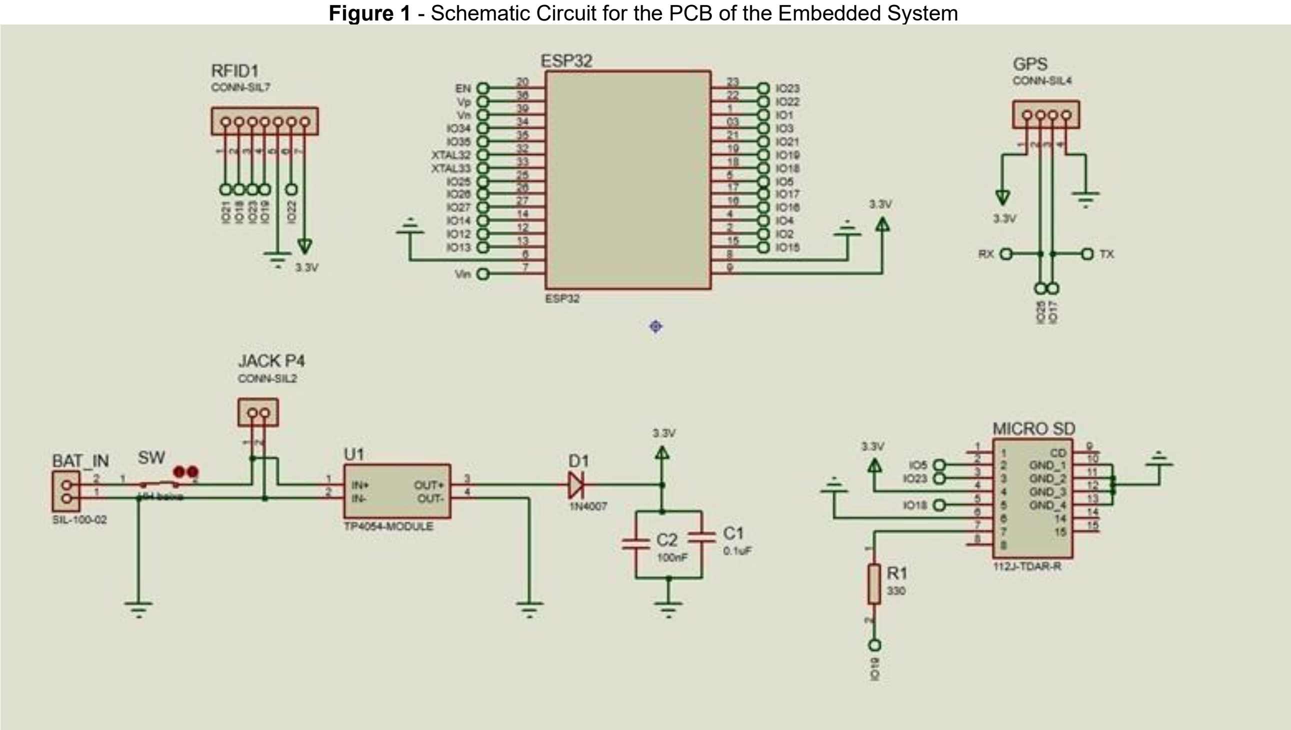
Figure 1 - Schematic Circuit for the PCB of the Embedded System



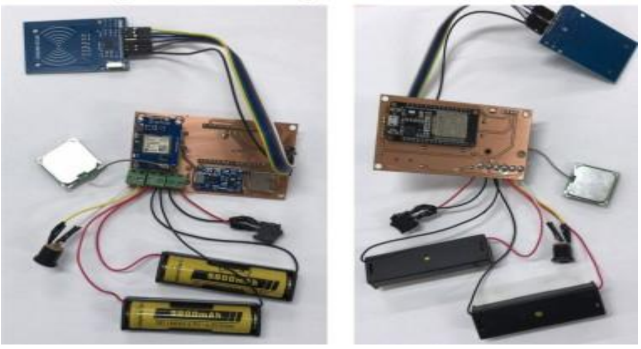
Source: Authorship.

RESULTS AND DISCUSSIONS

The layout was designed to be made of fiberglass board with double-sided copper coating. This reduces the total PCI measurements and makes it possible to enclose the embedded electronics in a box executed in a 3D printer. In this way, the project gains relatively small proportions, which do not hinder the work of the employees who will use the device during the harvest.

Finally, a bench test circuit was executed to certify the operation of the integration of the hardware with the code elaborated in the Arduino IDE development environment for the ESP32, as shown in Figure 2. After this stage, the final assembly of the prototypes has its final face according to Figures 3 and 4 and can then be sent for field testing.

Figure 2 - Test assembly for bench



Source: Authorship.

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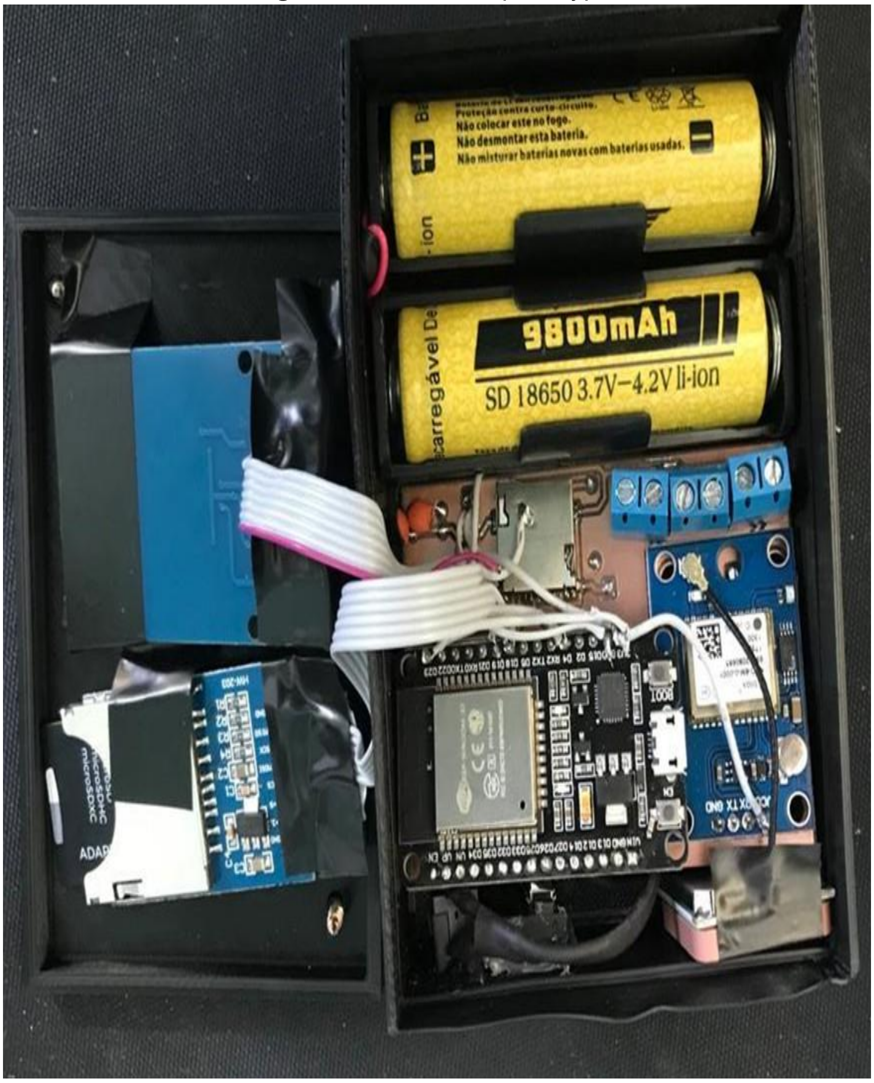
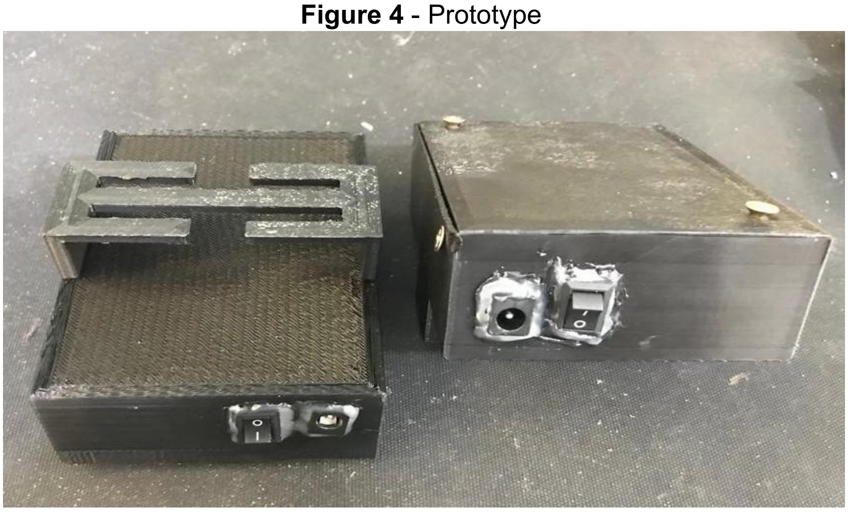
Figure 3 - Inside the prototype



Source: Authorship.

Figure 4 - Prototype



Source: Authorship.

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The developed system has the potential to contribute significantly to precision agriculture, allowing for more detailed monitoring of productivity in fruit plantations. However, it is necessary to address the identified limitations in order to optimize the system and reach its full potential. This can result in improvements in resource management and increased productivity, benefiting the Brazilian agricultural sector and research in general.

EXPECTED OUTCOMES

The embedded system developed will allow the collection and storage of data that will be used, later, for geostatistical analysis. This is possible through the mechanisms of georeferencing and identification of the boxes that receive the apple harvest. In addition, the hardware planning for the long-range specification will make it possible to use the equipment in the field with a forecast of battery charge duration for 24 hours. It is hoped to facilitate the experimental procedure that can occur without interruption of the work in the harvest of the fruits.

It is a lesson that unfortunately there are limitations in the Arduino IDE interface, so for later proceeds there is encouragement to carry out the ESP32 platform itself, in addition to an adjustment in the charging system that presented flaws in the PCD layout.

Finally, it is intended to assist the research and development of models capable of identifying which regions of the cultivated area are more productive, in order to improve the management of inputs and human resources in the orchard. Thus, the primary purpose of this area of research, which consists of increasing productivity and reducing costs, can be realized.

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REFERENCES

1. CEPEA (Center for Advanced Studies in Applied Economics). (n.d.). *Brazilian agribusiness GDP*. https://www.cepea.esalq.usp.br/br/pib-do-agronegocio-brasileiro.aspx

2. Inamasu, R. Y., & Bernardi, A. C. de C. (2014). *Precision agriculture: Results of a new look* (1st ed.). Embrapa.

3. Medina, J. (n.d.). *What is precision agriculture? Discover!* https://agropos.com.br/o-que-e-agricultura-de-precisao/

4. Molin, J. P., Amaral, L. R. do, & Colaço, A. F. (2015). *Precision agriculture* (1st ed.). Oficina de Textos.

5. Sousa, R. V. de, Lopes, W. C., & Inamasu, R. Y. (2014). Automation of agricultural machinery and implements: Embedded electronics, robotics and information management system. In *Information and communication technologies and their relations with agriculture* (pp. 215–232). Embrapa.