AgDataBox-IoT - Managing IoT data and devices on precision agriculture

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Abstract.

The increasing global population has resulted in a substantial demand for nourishment, which has prompted the agricultural sector to investigate ways to improve efficiency. Precision agriculture (PA) uses advanced technologies such as the Internet of Things (IoT) and sensor networks to collect and analyze field information. Although the advantages are numerous, the available data storage, management, and analysis resources are limited. Therefore, creating and providing a user-friendly web application that streamlines the optimization process is essential. Precise and agile management of agricultural properties, thereby improving decision-making. Farmers can exercise better control over sustainable soil management and IoT devices on their agricultural property by visualizing and analyzing field-collected data. With easy access to thematic maps and graphs generated from sensor data, farmers can analyze information and make informed decisions. This web application is designed to be user-friendly and freely accessible. It is integrated into the AgDataBox-IoT (ADB-IoT) platform, allowing existing functionalities to be used. With this application, farmers can plan the implementation of an IoT network, collect and analyze data, and monitor their IoT devices. ADB-IoT, a web app for precision agriculture, is available at http://academicapps.md.utfpr.edu.br/iot/.

Keywords.

Digital agriculture, internet of things, online systems, web application

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Introduction

Considering the above, the AgDataBox (ADB) project is being shaped and implemented as a free resource. It currently offers free computational tools for working with PA techniques, including ADB-Mobile for mobile devices, ADB-API, ADB-Map for thematic map generation and management zone creation, along with computational modules for interpolator selection, fertilizer and limestone recommendation, ADB-AplicNutrient, variable selection and management zone definition, data cleansing, ADB-Cleaning, and satellite image and UAV geoprocessing, ADB-RS, additionally, a new module proposed in this study aims to develop a configurable IoT environment integrated into the ADB platform for sensor network planning and the acquisition, storage, visualization, and analysis of field data.

Materials and methods

For the construction of the web application, the use of four Application Programming Interfaces (APIs) became indispensable: i) ADB-API, ii) Open Topo Data API, iii) IoT Control API, and iv) Sensor Position API. These APIs were employed for both data storage and the acquisition of resources. To illustrate the communication structure between the APIs and programming tools, a flowchart was created and is presented in Fig. 1.

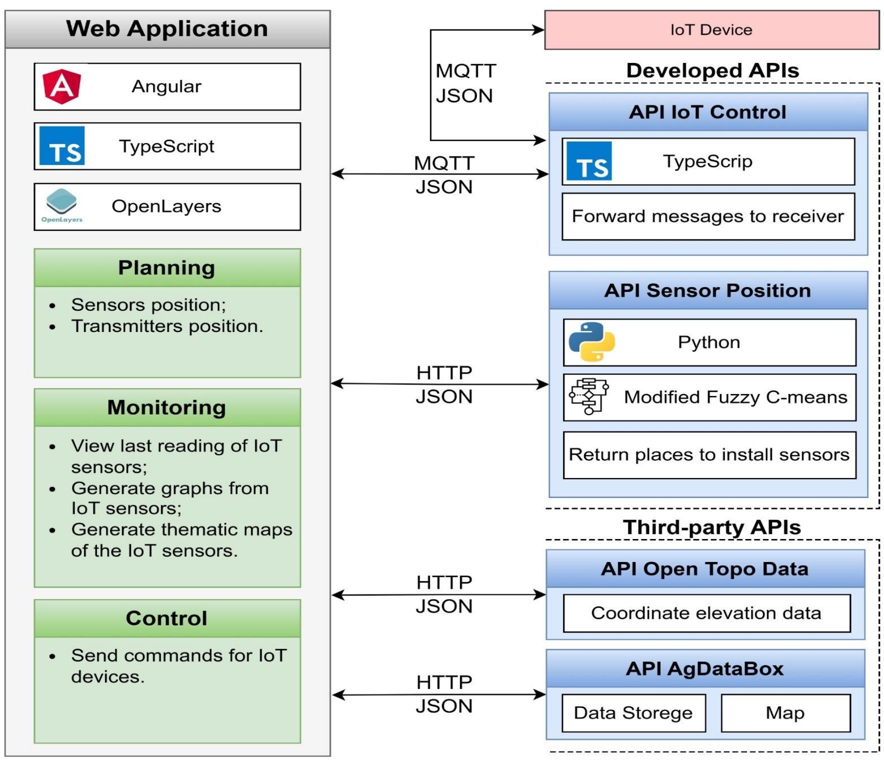

Fig. 1. Flowchart of the used and developed APIs.

i) ADB-API: A data storage solution was employed to persist information related to users, georeferenced data, IoT devices, sensors, actuators, and areas. Furthermore, the resources provided by the API were explored, notably the tools for thematic map production. The ADB-API was developed to assist in developing AP-oriented applications, offering help for agricultural data storage and management, and providing functionalities through HTTP requests (Bazzi, Jasse, et al. 2019). An HTTP server is essential to build and deploy distributed collaborative information systems on the Web (Oliveira et al. 2014).

ii) Open Topo Data API: This API is a source of open-source altitude data that can be copied and hosted on a private server, configurable with a range of open elevation datasets. This API makes it possible to obtain the elevation of a geographical coordinate (Mishra et al. 2021). This API was used to obtain elevation data to generate an elevation map of a property.

iii) IoT Control API: This API was developed for web applications and is responsible for conducting and controlling communication between the web application and IoT devices. TypeScript was used to create this API, along with the Message Queuing Telemetry Transport (MQTT) communication protocol. MQTT was selected because of its lightweight nature and capability to ensure message delivery even in fragile connections, making it widely used in IoT applications (Hillar 2017). The API includes connection authentication and message transmission authorization systems. This API was used to manage communication between the IoT devices and the web application.

iv) API Sensor Position: This API, developed in the Python programming language, calculates and indicates the installation location of sensors on an agricultural property. The API utilizes the algorithm proposed by Bazzi et al. (2019). The values of FPI and MPE are applied to determine the installation locations of the sensor.

Results and Discussion

The implemented solution is hosted on the Federal Technological University of Paraná - Campus Medianeira server and can be accessed through the following link: http://academicapps.md.utfpr.edu.br/iot/. Ensure you have a computer with internet access and a compatible web browser to use the application.

This study presents the integration of geospatial data visualization and IoT control functionalities within a web application tailored for precision agriculture. Users can visualize geographically referenced data such as fields, samples, thematic maps, devices, and sensors on a world map, thereby identifying the data collection location or sensor deployment site (Fig. 2).

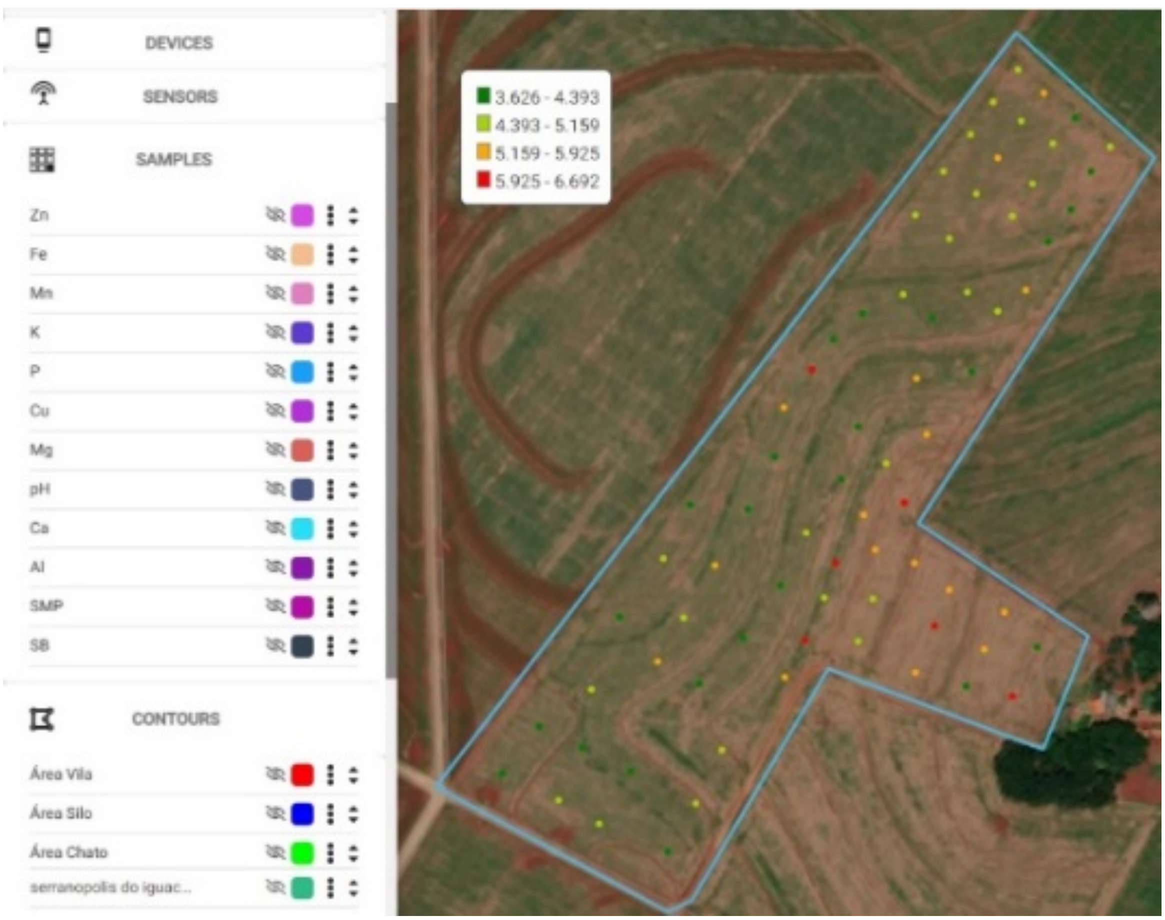

Fig. 2. Screenshot of the front end displaying the application's interface with field survey data.

Conclusion or Summary

In this study, we present the ADB-IOT, a web application for precision agriculture available at http://academicapps.md.utfpr.edu.br/iot/. This web application offers features such as continuous project recording, efficient management of agricultural zones, soil sampling, planning for IoT network deployment, data analysis, and network supervision. In addition, it offers features such as thematic charts and maps. These graphical representations make decision-making processes more objective, facilitating the adoption of sustainable agricultural practices and increasing the profitability of the farm sector. The module also allows users to strategically plan the deployment of sensors and signal transmitters strategically, enabling optimized equipment procurement while managing the costs associated with establishing a robust IoT infrastructure.

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