Geographic Database in Precision Agriculture for the Development of AI Research

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Abstract.
Agriculture 4.0 has profoundly transformed production processes by incorporating technologies such as Precision Agriculture, Artificial Intelligence, the Internet of Things, and telemetry. This evolution has enabled more accurate and timely decision-making in agriculture. In response to this movement, the Precision Agriculture Laboratory (AgriLab) of UTFPR, located in Medianeira, proposes the establishment of a consistent and standardized database. This database is continually updated with surveys from two commercial areas cultivated with corn and soybean in the Céu Azul municipality, Paraná. Gathered data encompasses physicochemical attributes of the soil and multispectral images captured by Unmanned Aerial Vehicles (UAVs). These images are subsequently processed to generate vegetation indices. AgriLab manages, organizes, and makes these data available on the AgCloud server, making them accessible to researchers and students worldwide. The objective is for this dataset to serve as a valuable resource for scientific studies on crops, bolstering research and advancements in the farming sector. Access to this repository can be obtained through the AgCloud server at the following link: http://agcloud.md.utfpr.edu.br/s/datasets.

Keywords.
big data, Agriculture 4.0, Precision agriculture

Introduction

Agriculture 4.0 has brought about a significant revolution in production processes, enhancing the ability to make decisions both accurately and swiftly. Nowadays, tools such as Precision Agriculture (PA), Artificial Intelligence (AI), the Internet of Things (IoT), and telemetry have become indispensable to modern agriculture (Hachisuca et al. 2023). In this context, we propose the creation of a comprehensive database derived from consistent surveys using remote sensing (RS) with the aid of UAVs (Unmanned Aerial Vehicles), as well as field data, including physicochemical soil attributes, crop management, microclimatic conditions, and productivity. Such data is crucial for on-farm agricultural management. However, it's typical for this type of data, generated from field surveys, to need more standardization and organization, emphasizing such standardization.

With this in mind, the Precision Agriculture Laboratory (AgriLab), based at the Federal University of Technology - Paraná (UTFPR), Medianeira Campus, proposes the application of protocols for the acquisition and provision of standardized, organized, and stored data. These are available to the scientific community to assist in research and the generation of products for agribusiness.

Materials and methods

The database is being structured over two commercial agricultural areas in the municipality of Céu Azul, Paraná, Brazil, under the central geographical coordinates of 25°06'33.7"S 53°49'50.6"W. Field A (15.66 ha; Figure 1) was planted with corn in September 2021, and Field B (23.91 ha) was sown with soybeans in October 2021. Both fields have been under a crop rotation system (soybean - corn - wheat) for over ten years. Additionally, the edaphoclimatic conditions of the region show an annual precipitation ranging from 1,100 to 1,920 mm and maintain an average temperature between 15-24°C. A sampling grid was established using the AgDatabox-Map platform (ABD-Map) (Michelon et al. 2019).

Figure 1- Experimental field

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Currently, the gathered data are from weekly surveys of the 2021/2022 corn and soybean crop seasons. They are divided into 1) data on soil physicochemical attributes, considering six subsamples per site, up to a depth of 0.20m. The physical analysis explored the soil particle distribution and its resistance to penetration. The chemical tests were conducted in a laboratory, following the methodology described by Teixeira et al. (2018), and 2) data from aerial surveys using multispectral images taken by a Spectral quadcopter equipped with a MicaSense Altum sensor. Flights were scheduled between October 2021 and February 2022, capturing images every week between 10 a.m. and 12 p.m. These images were subsequently processed in the Pix4Dmapper software to deduce vegetation indices, notably the Normalized Difference Vegetation Index (NDVI), Normalized Difference Red Edge Index (NDRE), and Green Leaf Index (GLI).

Results and Discussion

The database is currently expanding, containing data from one agricultural year of soil physicochemical attributes and aerial surveys with multispectral images covering the entire cycle of corn and soybean cultivation. Each UAV survey was processed by the AGRILAB Laboratory, affiliated with UTFPR. As a result, mosaics of the collected images were created and stored on the AgCloud server (cloud storage) designated for this purpose. All results are available at their respective links (Table 1).

Table 1 – Description of each data set and its corresponding link.

Description	Information	Access Link
Chemical and Textural	Data from 42 reports	*http://agcloud.md.utfpr.edu.br/s/datasets?path=UAV_data/CORN/attributes_info*
Vector Point File	Vegetation index value calculated for each pixel	*http://agcloud.md.utfpr.edu.br/s/datasets?path=UAV_data/CORN/grid_05x05*
Vegetation Indices	Calculated indices (NDVI, NDRE, IVF) for corn and soy crops.	*http://agcloud.md.utfpr.edu.br/s/datasets?path=UAV_data/CORN/indexes*
Raw Field-Surveyed Images	Unprocessed images	*http://agcloud.md.utfpr.edu.br/s/datasets?path=UAV_data/CORN/raw_images*
Pre-processed Images	All image mosaics obtained are corrected for distortions, and the spatial resolution of these mosaics is 0.50 m.	*http://agcloud.md.utfpr.edu.br/s/datasets?path=UAV_data/CORN/reflectance_mosaic*
Vector File Format (shapefile)		*http://agcloud.md.utfpr.edu.br/s/datasets?path=UAV_data/CORN/study_area*
Files in txt format	There are nine files in txt format. These files contain the corresponding values to the digital values of each band and the calculated vegetation indices	*http://agcloud.md.utfpr.edu.br/s/datasets?path=UAV_data/CORN/txt_data*

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Conclusion or Summary

The Precision Agriculture Laboratory (AgriLab) of UTFPR conducted data collection and processing in agricultural areas of Céu Azul, Paraná, producing detailed data on corn and soybean crops for the 2021/2022 cycle. These data, properly organized and stored, are freely available to researchers and students worldwide, serving as a resource for scientific studies related to both crops. Access to this repository can be made through the AgCloud server at the link: http://agcloud.md.utfpr.edu.br/s/datasets.

Acknowledgments

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