

PhenomeInsight – An Integrated Web-GIS Platform for Generation, Visualization, and Analysis of Strawberry Phenotypes for Breeding

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Summary

PhenomeInsight is a web-based GIS application developed to streamline the generation and analysis of field maps using drone images and visualize crop growth status. This tool allows breeders and growers to quickly assess crop conditions and support field management strategies. Currently, PhenomeInsight offers free field map generation, downloading, and visualization exclusively to UF faculty. It also provides various Vegetation Indices (VIs) to help users evaluate crop growth. Additionally, it features hotspot visualization to quickly identify areas needing immediate attention and intervention.

Background

The use of drone or uncrewed aerial vehicle (UAV) images in agriculture is becoming increasingly common, providing valuable insights into crop health and growth. However, third-party image processing services can be expensive, slow, and often limit access to original data. Additionally, interpreting and utilizing field maps can be complex and timeconsuming for non-experts. PhenomeInsight (devphenomeinsight.rc.ufl.edu/) addresses these challenges by offering a user-friendly platform that simplifies the generation and visualization of field maps. It empowers breeders and growers to easily interpret crop growth information without needing advanced technical skills or external assistance.

Methods

PhenomeInsight is hosted on UF's Web Application Hosting Service (PubApps) for storing raw data and visualizing field maps. Raw data is transferred to and organized in a new folder on UF's HiperGator supercomputer. Then, an image processing pipeline developed using Structure-from-Motion photogrammetry generates the field map automatically. The generated field maps are then synced back to PubApps, and users are notified when the data is ready for visualization. The backend of the visualization panel is built using R Shiny, an opensource toolkit designed for interactive data visualization. Users can generate maps in different VIs and view them on the map panel. Statistical analysis of VI values can highlight hot and cold spots for decision support.

Results

Image Upload and User Notification

The application supports uploading various raw data types, including image files, folders containing images, and compressed files (e.g., ZIP). Users must specify the image type – RGB, multispectral, or thermal, before uploading (Fig. 1).

Figure 1. Image uploading panel

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Each image processing task is assigned a unique Task ID. Users receive an email notification as soon as their images are processed and ready for download. Once the field maps are generated, including an orthomosaic field map with spectral information and a digital elevation model with height information, users can input the Task ID to load the generated field maps into the web browser for visualization and further analysis (Fig. 2).

Figure 2. Field map visualization panel



Interactive Map and VIs Visualization

PhenomeInsight displays high-resolution field maps, allowing users to explore various spatial aspects of their fields. The interactive map feature enables zooming, panning, and close inspection of selected areas, helping to identify patterns and anomalies in the field. In addition, users can select multiple VIs from a dropdown menu (Fig. 2) and visualize colorcoded maps to monitor crop growth status (Fig. 3).

Figure 3. Interactive map and VI visualization

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VI-Based Hotspot Analysis

PhenomeInsight generates various VIs, such as NDVI for chlorophyll content, ExG for canopy coverage, and OSAVI for plant vigor. It also allows users to customize the symbology and classification of VIs, making it easier to highlight specific attributes like healthy versus stressed vegetation. Integrated hotspot analysis tools identify areas with statistically significant values (Fig. 4). These hot- and cold- spots are visualized on the map using distinct colors, enabling quick identification of zones that may need immediate attention. The interactive dashboard allows users to zoom in and explore the underlying conditions of these areas, supporting targeted decision-making and effective resource management.

Figure 4. Visualization of hot- and cold-spot analysis using VI values



Takeaways

- PhenomeInsight is designed to be a cost-effective web-GIS tool, making UAV imagery generation, analysis, and visualization accessible for breeders and growers.
- Additionally, it offers the potential to effectively monitor and utilize phenotypic traits, contributing to plant breeding selections.

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