2024-25 HIVE Summer Internship Project

Heterogeneous Network Layers Data Visualization for Sustainable Agriculture

42SAE_EECMS_SustainableAgriDataViz

Primary Academic Supervisor
Mahbuba Afrin

Project Background

Modern agriculture is increasingly reliant on data from various high-tech sources, such as UAV (Unmanned Aerial Vehicles), IoT (Internet of Things) sensors, and satellite imagery. These technologies provide critical insights into factors like crop health, soil moisture, and environmental conditions. However, integrating and visualizing data from these heterogeneous network layers poses significant challenges. Each data source operates differently, creating a complex web of information that is difficult to interpret in a cohesive manner. The aim of this project is to develop a comprehensive visual analytics system that integrates and visualizes data from these diverse sources. By creating an interactive and intuitive dashboard, the project will enable users to make sense of complex datasets, uncovering patterns and trends that support informed decision-making. This approach aims to enhance precision agriculture by providing actionable insights that can improve resource management, boost crop yields, and promote sustainable farming practices. Students will gain hands-on experience with advanced data visualization techniques and the challenges of managing multi-source data. They will contribute to developing tools that could transform agricultural practices, making a tangible impact on the efficiency and sustainability of food production.

Project Description, Expected Outputs, Possible Stretch Goals

The internship project focuses on creating a visual analytics dashboard that integrates and visualizes data from UAV swarms, IoT sensors, and satellite imagery. The goal is to develop a user-friendly interface that allows users to interact with real-time data and gain insights into various agricultural factors. The dashboard will help in monitoring crop health, soil conditions, and environmental variables, providing a comprehensive view of the agricultural landscape. Expected Outputs:

- A functional dashboard that integrates data from different network layers, providing real-time visualizations of key agricultural metrics.
- Seamless integration of data from UAVs, IoT sensors, and satellites into a unified platform.
- Features for detecting patterns, trends, and anomalies in the data to support decision-making.
- Comprehensive documentation of the development process, challenges encountered, and solutions implemented.

Possible Stretch Goals:
- Implement predictive models to forecast future conditions based on historical data and current trends.
- Develop advanced interactive features, such as customizable data filters and dynamic visualizations.
- Integrate additional data sources, such as weather forecasts or market trends, to provide a more holistic view of agricultural conditions.

Links to background reading and any relevant recent work in the field

[1] Tian, X., Afrin, M., Mistry, S., Mahmud, R., Krishna, A., & Li, Y. (2024). MURE: Multi-layer real-time livestock management architecture with unmanned aerial vehicles using deep reinforcement learning. Future Generation Computer Systems, 161, 454-466.
[2] Afrin, M., Jin, J., Rahman, A., Gasparri, A., Tian, Y. C., & Kulkarni, A. (2021). Robotic edge resource allocation for agricultural cyber-physical system. IEEE Transactions on Network Science and Engineering, 9(6), 3979-3990.
[3] Afrin, M., Jin, J., Rahman, A., Li, S., Tian, Y. C., & Li, Y. (2023). Dynamic task allocation for robotic edge system resilience using deep reinforcement learning. IEEE Transactions on Systems, Man, and Cybernetics: Systems.
[4] Kubicek, P., Kozel, J., Stampach, R., & Lukas, V. (2013). Prototyping the visualization of geographic and sensor data for agriculture. Computers and electronics in agriculture, 97, 83-91.

What type of visualisation will the student develop or produce?

The student will develop an interactive visualization dashboard that integrates data from UAVs, IoT sensors, and satellite imagery. The dashboard will feature real-time visualizations of crop health, soil moisture, and environmental conditions using interactive charts,

heatmaps, and geographical overlays. Key outputs will include dynamic graphs for trend analysis, anomaly detection tools, and user-friendly data filters to provide actionable insights for precision agriculture.

How will the visualisation contribute to your research outcomes?
The visualization will enhance research outcomes by providing a unified, real-time view of diverse agricultural data, facilitating better decision-making. It will integrate data from UAVs, IoT sensors, and satellites to identify patterns and trends in crop health and soil conditions. Achieving this involves developing interactive charts and heatmaps to detect anomalies and monitor changes. This will support precision agriculture by improving resource management through actionable insights.

If the project is successful, where would you consider publishing the results?
The outcome will be target to publish in any Q1 Journal including Journal of Computers and Electronics in Agriculture, Future Generations Computer Systems or any top ranked conference.

Draft Project Timeline:

Week 1

- Full day HIVE induction.
- Project induction with primary supervisor.
- Develop project plan with HIVE and academic team.
- Literature review and project scope refinement.

Week 2

- Finalize data sources and integration methods.
- Begin preprocessing and organizing data.
- Start initial development of visualizations and dashboards.

Week 3

- Continue the visualizations and dashboards development.
- Implement interactive features and tools.
- Begin testing visualizations for functionality.

Week 4

- Refine visualizations based on initial testing.
- Start creating detailed documentation for the visualizations.
- Meet with supervisor to review progress.

Week 5

Continue refinement and testing of visualizations.

Week 6

- Finalize visualizations and ensure integration with HIVE displays.
- Conduct in-depth testing and gather user feedback.
- Begin preparing preliminary findings and drafts for the final report.

Week 7

Continue documentation and reporting.

Week 8

Prepare for the final presentation by developing slides and summaries.

Week 9

Conduct final review sessions with the primary supervisor and HIVE team.

Week 10

- Final presentation showcase.
- Submit the final report and complete any remaining tasks.

Student Experience and Supervision:

How often will you meet with the student over the 10-week period?

Once per week, if needed twice

Your work desk location and the location of student desk

314.326 Student location could be online, or Bentley campus

Student Attributes:

Please indicate any preference for student's academic discipline or field of study

Computer Science, Data Science

What competencies are required to start this project

Beginner - 2D image and/or video software (e.g. Adobe Suite, Sony Vegas)
Beginner - 3D modelling software (e.g. Blender, 3ds Max)
Advanced - Data structures, analytics, statistical modelling

Do you have any other student attributes you think are important to the project?

Critical Thinking ability, coding in Python