IT4010 – Research Project - 2024
Topic Assessment Form

Project ID: 24-25J-064

1. Topic (12 words max)

SMART GREENHOUSES DECISION SUPPORT SYSTEMS FOR TOMATO CULTIVATION

2. Research group the project belongs to

Centre of Excellence for AI (CEAI)

3. Research area the project belongs to

Machine Learning (ML)

4. If a continuation of a previous project:

Project ID	-
Year	-

5. Brief description of the research problem including references (200 – 500 words max) – references not included in word count.

The agricultural sector, particularly tomato cultivation, faces several critical challenges that hinder optimal production efficiency and yield quality. Efficient water management is crucial for tomato cultivation, as both over-watering and under-watering can adversely affect plant health and yield. Traditional methods often rely on fixed schedules that do not account for real-time soil and environmental conditions. By leveraging ML algorithms trained on sensor data (e.g., soil moisture, temperature, and humidity), it is possible to dynamically adjust watering schedules, ensuring optimal hydration levels for tomato plants. This approach not only conserves water but also enhances plant growth and productivity. Tomato plants are susceptible to various diseases that can significantly reduce yield and quality. Early and accurate detection is essential for effective disease management. Convolutional Neural Networks (CNNs), a class of DL algorithms, have shown great promise in image-based disease detection. By training CNN models on annotated images of diseased and healthy tomato plants, it is possible to develop a system that can accurately identify and diagnose various diseases, enabling timely and targeted interventions. Optimizing fertilization is critical for maintaining soil health and ensuring that tomato plants receive the necessary nutrients for optimal growth. Traditional fertilization practices often follow generalized recommendations that may not account for specific soil conditions and environmental factors. ML algorithms can analyze data on soil nutrient levels, temperature, humidity, and other environmental variables to recommend personalized fertilization schedules. This tailored approach can enhance nutrient uptake, improve plant health, and increase yields. Determining the right time to harvest tomatoes is vital for maximizing yield quality and market value.

Traditional methods of predicting harvest times often rely on subjective assessments and fixed calendars. ML techniques can analyze growth patterns, environmental parameters, and historical data to forecast the ideal harvest time more accurately. This approach can help farmers plan their activities better and reduce post-harvest losses, ensuring that tomatoes are harvested at their peak quality. Integrating ML and DL technologies into tomato cultivation addresses critical challenges in water management, disease detection, fertilization optimization, and harvest prediction, leading to more efficient, sustainable, and profitable farming practices.

References

[1] Boursianis, A. D., et al. (2020). Internet of Things (IoT) and Agricultural Unmanned Aerial Vehicles (UAVs) in smart farming: A comprehensive review. IEEE Internet of Things Journal, 8(1), 415-429.

[2] Friedrich, H., & El-Sayed, M. (2018). Smart farming: An enhanced pursuit for sustainable remote agricultural monitoring and control. IOP Conference Series: Earth and Environmental Science, 136, 012045.

[3] Too, E. C., et al. (2019). A comparative study of fine-tuning deep learning models for plant disease identification. Computers and Electronics in Agriculture, 161, 272-279.

[4] Sladojevic, S., et al. (2016). Deep neural networks based recognition of plant diseases by leaf image classification. Computational Intelligence and Neuroscience, 2016, 1-11.

[5] Ashraf, M. I., et al. (2020). Intelligent disease diagnosis for tomato plant using hybrid feature extraction. Electronics, 9(7), 1176.

[6] Sharma, N., et al. (2020). Precision agriculture: Towards sustainable development in Indian agriculture. IOP Conference Series: Earth and Environmental Science, 486, 012066.

[7] Patel, K. K., et al. (2012). Machine vision system: a tool for quality inspection of food and agricultural products. Journal of Food Science and Technology, 49, 123-141.

[8] Pantazi, X. E., et al. (2016). Wheat yield prediction using machine learning and advanced sensing techniques. Computers and Electronics in Agriculture, 121, 57-65.

6. Brief description of the nature of the solution including a conceptual diagram (250 words max)

This project integrates advanced machine learning (ML) and deep learning (DL) techniques to optimize tomato cultivation in smart greenhouses. The first component focuses on predicting the precise water needs for tomato plants. By analyzing sensor data such as soil moisture, temperature, light, and humidity, ML models dynamically adjust irrigation, ensuring efficient water use and improved plant health. When soil humidity is low, the system automatically activates water pumps, and if temperature levels are unsuitable, it turns on cooling or exhaust fans to maintain optimal conditions.

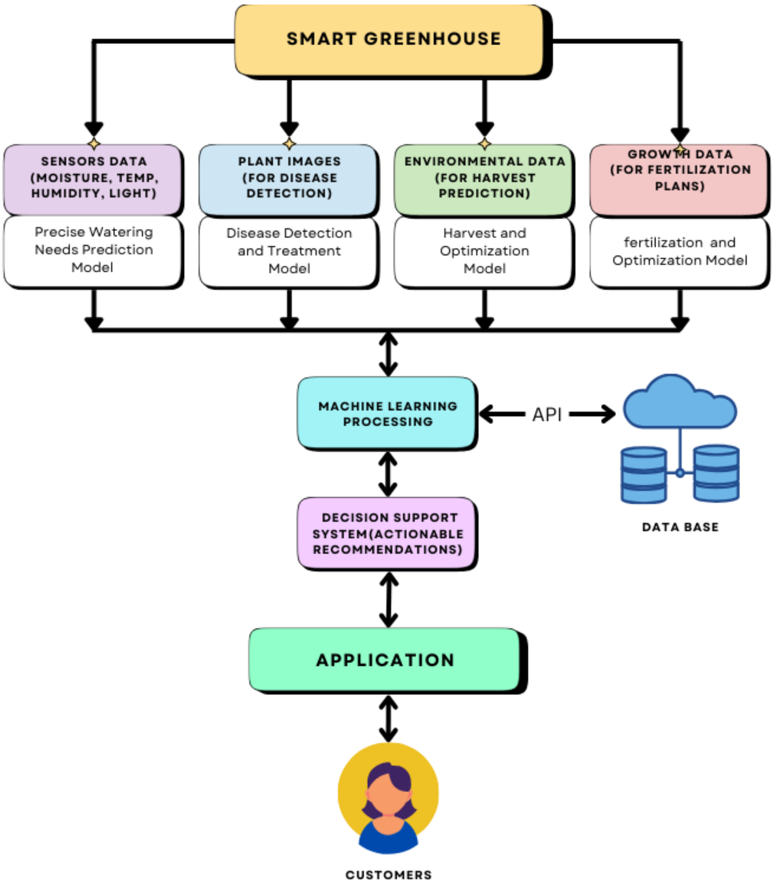
The second component focuses on detecting tomato diseases and recommending treatments using Convolutional Neural Networks (CNNs). This system accurately identifies diseases from plant images and suggests targeted interventions, enabling early diagnosis and reducing crop loss and pesticide use.

The third component optimizes fertilization schedules through tailored ML models. These models analyze soil nutrient levels and environmental data to create personalized fertilization plans, enhancing plant growth and yield while minimizing environmental impact from over-fertilization.

The fourth component forecasts optimal harvest dates using ML models that consider plant growth and environmental conditions. This predictive capability ensures tomatoes are harvested at peak ripeness, maximizing quality and market value.

In conclusion, this integrated decision support system leverages ML and DL to enhance efficiency, sustainability, and yield in tomato cultivation. By addressing key challenges in watering, disease management, fertilization, and harvesting, this project represents a significant advancement in agricultural technology for smart greenhouses.

Conceptual Diagram



7. Brief description of specialized domain expertise, knowledge, and data requirements (300 words max)

The development and deployment of a decision support system for smart greenhouses in tomato cultivation require specialized expertise in multiple domains. Proficiency in machine learning (ML) and deep learning (DL) is crucial, particularly in using convolutional neural networks (CNNs) for disease detection from plant images and regression models for predicting watering schedules, optimizing fertilization, and forecasting harvest dates. This includes skills in data preprocessing, feature extraction, and model evaluation to ensure reliable performance. Additionally, understanding sensor technology and data integration methods is vital for collecting and analyzing real-time data on soil moisture, temperature, humidity, and other environmental factors. Expertise in data cleaning techniques is required to manage noisy and incomplete data, and knowledge of Internet of Things (IoT) frameworks is beneficial for integrating various data sources into a cohesive system.

Horticultural expertise is essential, encompassing knowledge of tomato plant biology, growth stages, disease symptoms, and nutrient requirements. This ensures that the recommendations provided by the ML models are biologically sound and practical for farmers. Furthermore, skills in statistical modeling, time series analysis, and environmental impact assessment are necessary for analyzing environmental parameters and their effects on tomato growth. Accurate forecasting of harvest dates relies on understanding the interactions between different environmental factors.

The system's data requirements include real-time sensor data on soil moisture, temperature, and humidity; annotated images of tomato plants for training CNNs in disease detection; soil data on nutrient levels and composition; and environmental data on weather conditions such as temperature, humidity, and rainfall. Additionally, growth data detailing tomato plant stages, phenological observations, and yield records are crucial. These datasets, sourced from agriculture-related fields and departments, enable the creation of a efficient decision support system for tomato cultivation in smart greenhouses. Using real datasets ensures the ML models are trained and validated on accurate and relevant information, enhancing the reliability and applicability of the system's recommendations for optimizing agricultural practices.

8. Objectives and Novelty

Main Objective The main objective of this project is to implement advanced machine learning (ML) and deep learning (DL) techniques to revolutionize tomato cultivation in smart greenhouses. By predicting optimal watering schedules, detecting diseases, optimizing fertilization plans, and forecasting harvest dates, the project aims to enhance agricultural efficiency, improve yield quality, and promote sustainable farming practices. Using real datasets collected from agriculture-related fields and departments to train these ML models, the project seeks to maximize crop productivity while minimizing resource use and environmental impact, ultimately benefiting farmers and the broader agricultural industry.			
Member Name	Sub Objective	Tasks	Novelty
Najas M.N.M.	Detecting tomato diseases and recommend appropriate treatment	1. Select data from Kaggle. 2. Label the images with corresponding disease types. 3. Preprocess the images (resize, normalize, augment) for model training. 4. Develop a CNN model architecture suitable for image classification. 5. Train the CNN model on the labeled dataset and evaluate its performance	Employing CNNs to identify disease patterns in tomato plants and recommend appropriate treatment

Thrimavithana V.D.	Optimizing fertilization schedules	1. Gather soil nutrient data and environmental conditions. 2. Collect historical fertilization schedules and crop yield data. 3. Preprocess the data to handle missing values and normalize it. 4. Choose appropriate hybrid ML models. 5. Train the models using the preprocessed data to optimize fertilization schedules.	Leveraging ml to tailor fertilization plans based on soil nutrient data and environmental conditions
Asardeen A.	Predicting optimal watering schedules	1. Develop and deploy an IoT device in the tomato greenhouse fields to gather real-time sensors data (soil moisture, temperature, humidity, light) and environmental conditions. 2. Clean, normalize, and preprocess the collected data to ensure consistency and handle missing values and outliers. 3. Use ML models to analyze the preprocessed real-time sensor data and environmental conditions. 4. Implement the analyzed data to manage and optimize precise	Introducing ML model that predict the optimal watering schedule and precise amount of water needed based on current environmental conditions and real-time sensors data, thereby optimizing water usage for healthier tomato plants and more efficient resource management.

		tomato irrigation in the greenhouse fields.	
I.H.N.S. Jayaneththi	Forecasting tomato harvest dates	1. Collect growth data of tomato plants, including stages of development. 2. Gather environmental data such as temperature, humidity, and light exposure. 3. Preprocess and normalize the collected data. 4. Develop and train ML models to predict harvest dates. 5. Validate the model predictions with historical harvest data	Applying ml models to predict the best harvest time using growth data and environmental factors.

9. Supervisor checklist

a) Does the chosen research topic possess a comprehensive scope suitable for a final-year project?

Yes	✓	No	

b) Does the proposed topic exhibit novelty?

Yes	✓	No	

c) Do you believe they have the capability to successfully execute the proposed project?

Yes	✓	No	

d) Do the proposed sub-objectives reflect the students' areas of specialization?

Yes	✓	No	

e) Supervisor's Evaluation and Recommendation for the Research topic:

Highly Recommended

10. Supervisor details

	Title	First Name	Last Name	Signature
Supervisor	**Ms.**	**Geethanjali**	**Wimalaratne**	
Co-Supervisor	Mr.	Samantha	Thelijjagoda	
External Supervisor				
Summary of external supervisor's (if any) experience and expertise				

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Topic Assessment Form

<u>This part is to be filled by the Topic Screening Panel members.</u>

Acceptable: Mark/Select as necessary

Topic Assessment Accepted	
Topic Assessment Accepted with minor changes (should be followed up by the supervisor)*	
Topic Assessment to be Resubmitted with major changes*	
Topic Assessment Rejected. Topic must be changed	

* Detailed comments given below

Comments

The Review Panel Details

Member's Name	Signature

*__Important__:

1. According to the comments given by the panel, make the necessary modifications and get the approval by the **Supervisor** or the **Same Panel**.
2. If the project topic is rejected, identify a new topic, and follow the same procedure until the topic is approved by the assessment panel.