IT4010 Research Project – 2025 July

Topic Assessment Form

Project ID: 25-26J-299

1. Topic (12 words max)

SmartRose: AI-IoT Platform for Smart Greenhouse Rose Farming in Sri Lanka

2. Research group the project belongs to

CoEAI - Centre of Excellence for AI

3. Specialization of the project belongs to

Information Technology (IT)

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.

Rose cultivation is a key component of Sri Lanka's floriculture industry, particularly in the central highlands such as Nuwara Eliya and Kandy, where favorable climatic conditions support year-round greenhouse production. However, most middle scale rose farmers operate semi-controlled greenhouses using manual methods for irrigation, fertilization, and pest control. These farmers often rely on experience-based decisions rather than scientific data, resulting in over-irrigation, nutrient imbalance, and poor disease prevention. Inadequate environmental monitoring and lack of automation lead to yield fluctuations and reduced flower quality, threatening the sustainability of small and medium-scale greenhouse operations. In contrast, large-scale export-oriented farms employ fully automated climate control systems, but such solutions are too costly and technically demanding for local mid-level growers.

Studies have shown that IoT-driven irrigation and nutrient systems can minimize water use, improve fertilizer accuracy, and enhance plant growth efficiency [1]– [3]. Other research highlights the use of AI and machine-learning models for greenhouse pest and disease forecasting, achieving high prediction accuracy under controlled environments [4]. Despite their success, these systems are primarily developed for industrial-scale farms with stable connectivity and expensive sensor networks, making them impractical for small or medium-scale tropical greenhouses.

In the Sri Lankan context, low-cost IoT prototypes have been successfully implemented for open-field crops, confirming that affordable sensor-based automation is technically feasible [5]. However, their application to greenhouse floriculture particularly rose farming remains largely unexplored. Additionally, post-harvest management poses another major challenge. Studies have shown that treatments with sucrose, citric acid, and germicides can extend rose vase life [6], [7]. Yet, no integrated IoT or AI-based systems currently monitor post-harvest freshness or predict flower quality in real time for local florists.

International research further emphasizes the potential of combining AI with IoT for greenhouse optimization, including temperature regulation, irrigation scheduling, and nutrient management [8]. Nevertheless, such systems are often complex, capital-intensive, and designed for large-scale commercial operations in Europe and East Asia. There remains a significant technological and affordability gap for Sri Lankan farmers operating low-cost, semi-automated greenhouses.

Hence, there is a clear research gap in developing a localized, affordable, and scalable AI–IoT greenhouse management platform for rose cultivation. Such a system should integrate smart irrigation, nutrient intelligence, early disease detection, and freshness monitoring into a single decision-support framework. Addressing this gap will empower Sri Lankan middle-scale greenhouse rose farmers and florists with data-driven decision-making tools, improving yield quality, resource efficiency, and post-harvest profitability, while supporting the nation's long-term vision for smart and sustainable agriculture.

References

[1]O. Moreira *et al.*, "Development of an Intelligent Irrigation System for a Rose Cultivation Based on IoT," *IEEE ANDESCON*, pp. 1–6, Sep. 2024, doi: https://doi.org/10.1109/andescon61840.2024.10755850.

[2]J. B. Chusan, F. A. Idrovo, A. L. Peralta, and M. Lucero-Tenorio, "Development and deployment of a device to accurately measure and transmit precision agriculture data in the context of cultivating roses," *2023 IEEE Colombian Caribbean Conference (C3)*, pp. 1–6, Nov. 2023, doi: https://doi.org/10.1109/c358072.2023.10436184.

[3]B. Doraswamy, K. L. Krishna, Boru Bedaya, and T. Murari, "Extreme Learning Machine based Smart Rose Cultivation Incorporated with IoT Sensors," pp. 1348–1353, Apr. 2025, doi: https://doi.org/10.1109/ictmim65579.2025.10988156.

[4]A. Tay, F. Lafont, and J.-F. Balmat, "Forecasting pest risk level in roses greenhouse: Adaptive neuro-fuzzy inference system vs artificial neural networks," *Information Processing in Agriculture*, Nov. 2020, doi: https://doi.org/10.1016/j.inpa.2020.10.005.

[5]C. Laksiri, M. Shafras, S. Rathnayake, and D. Ranasinghe, "IOT BASED SMART IRRIGATION SYSTEM FOR SRI LANKAN AGRICULTURE," 2227. Available: https://www.irjmets.com/uploadedfiles/paper/issue_3_march_2022/20397/final/fin_irjmets1648731851.pdf

[6]K. Ichimura, M. Taguchi, and Ryo Norikoshi, "Extension of the Vase Life in Cut Roses by Treatment with Glucose, Isothiazolinonic Germicide, Citric Acid and Aluminum Sulphate Solution," *Jarq-japan Agricultural Research Quarterly*, vol. 40, no. 3, pp. 263–269, Jan. 2006, doi: https://doi.org/10.6090/jarq.40.263.

[7]S. Bist and S. K. Hom, "Effect of Sucrose and Citric Acid in Vase Life of Rose," *Journal of Agriculture and Horticulture Research*, vol. 7, no. 2, pp. 01-13, Nov. 2024, doi: https://doi.org/10.33140/JAHR.07.02.01.

[8] C. Maraveas, "Incorporating Artificial Intelligence Technology in Smart Greenhouses: Current State of the Art," *Applied Sciences*, vol. 13, no. 1, p. 14, Dec. 2022, doi: https://doi.org/10.3390/app13010014.

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

The proposed solution, SmartRose: AI–IoT Platform for Smart Greenhouse Rose Farming in Sri Lanka, is designed to assist middle-scale greenhouse rose farmers and florists through real-time monitoring, predictive analytics, and intelligent decision support. The system integrates low-cost IoT sensors, ESP32 microcontrollers, and machine-learning (ML) models to optimize greenhouse rose cultivation from growth to post-harvest stages.

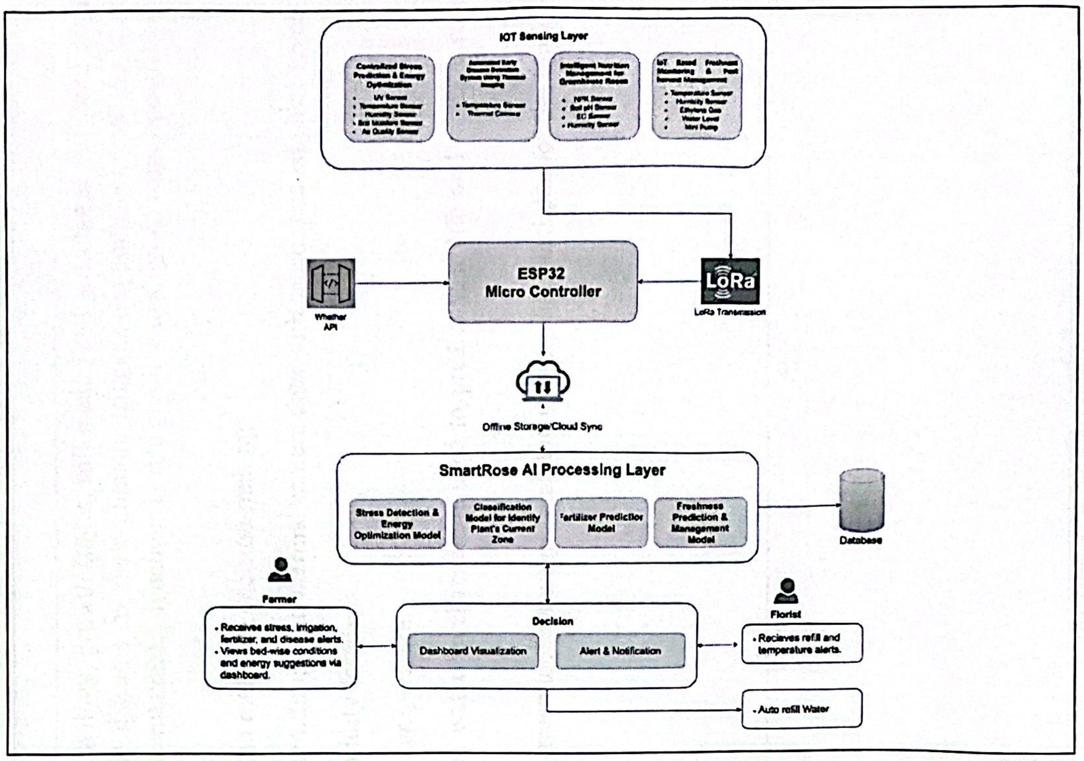
- **Component 1 – Centralized Stress Prediction & Energy Optimization System** monitors environmental conditions in multiple greenhouses using LoRa-connected sensors. Predicts flower bed stress levels using machine learning and recommends energy-saving actions for lights, misting, and ventilation. Displays zone-wise insights through a centralized dashboard with offline sync support.

- **Component 2 – Automated Early Disease Detection System Using Thermal Imaging** monitors the health of rose plants in the green hut by measuring the temperature difference (ΔT) between the plant canopy and the ambient air using a thermal sensor module. This (ΔT) data is fed into a classification model, which automatically assesses the plant's condition. The output classifies the plant into three zones: Green (Healthy), Yellow (Caution), or Red (Potential Damage). Since fungal diseases often manifest through temperature/humidity fluctuations, an elevated temperature in the Red Zone triggers an immediate alert to the user, prompting necessary preventative action before visible disease progression occurs.

- **Component 3 – Intelligent Nutrition Management for Greenhouse Roses** monitors real-time NPK, pH, EC, and moisture data, predicts nutrient changes using AI, and provides stage-based fertilizer recommendations for balanced greenhouse nutrition.

- **Component 4 – IoT Based Freshness Monitoring & Post harvest Management** assists florists predict vase life and freshness by monitoring temperature, humidity, ethylene gas, and water levels. To increase the lifespan of roses and maintain post harvest quality, the system automatically adds preservatives and refills water based on AI and IoT sensors that predict freshness.

Together, these components form an affordable, localized, and data-driven smart greenhouse ecosystem, enabling Sri Lankan rose farmers and florists to achieve higher productivity, better resource efficiency, and improved flower quality.



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

The SmartRose project integrates multiple specialized domains to create an intelligent, data-driven platform for greenhouse-based rose farming in Sri Lanka. It requires multidisciplinary expertise in Internet of Things (IoT), artificial intelligence (AI), data analytics, and agricultural sciences to ensure both technical reliability and agronomic accuracy.

From the technical domain, expertise in IoT system design is required to develop and connect greenhouse sensors for soil moisture, temperature, humidity, light intensity, NPK, pH, and ethylene gas monitoring. Skills in microcontroller programming, real-time data processing, and cloud integration are essential for implementing edge–cloud communication. Knowledge of machine learning (ML) and AI model development is needed to build predictive models for irrigation scheduling, disease risk analysis, nutrient optimization, and freshness prediction.

From the agronomic perspective, domain knowledge in rose physiology, growth stages, soil media, and greenhouse environmental parameters is vital. Familiarity with common Sri Lankan rose diseases as their climatic triggers, supports accurate decision thresholds. Expertise in fertilizer formulation, fertigation, and nutrient uptake dynamics is also required to align AI recommendations with real-world cultivation practices.

The project depends on diverse datasets for ML model training and real-time decision-making:

- **Sensor data:** soil moisture, NPK, pH, air temperature, humidity, light, thermal camera data with sensor and ethylene levels
- **Weather data:** rainfall probability, temperature, and humidity forecasts.
- **Plant data:** growth stage, fertilizer schedule, and plant's temperature.
- **Post harvest data:** temperature, humidity, ethylene gas, water level readings used to predict vase life and manage rose freshness after harvest.

Together, these datasets enable SmartRose to deliver intelligent greenhouse management and user-friendly insights for Sri Lankan rose farmers and florists.

8. Objectives and Novelty

Main Objective			
To design and develop **SmartRose**, an AI–IoT-based smart greenhouse management platform that assists Sri Lankan middle-scale rose farmers and florists in monitoring, predicting, and optimizing greenhouse climate conditions, irrigation, nutrient application, disease prevention, and post-harvest freshness through real-time data analytics and intelligent automation.			
Member Name with Registration No	**Sub Objective**	**Tasks**	**Novelty**
IT22888648	To develop a centralized LoRa-based system for stress prediction and energy optimization in multi-greenhouse rose farming using real-time sensor data and machine learning.	• Deploy LoRa-connected sensors to monitor UV, temperature, humidity, air quality, and soil moisture • Implement a centralized gateway with offline data storage and cloud sync • Train an ML model to classify stress conditions for each flower bed • Recommend energy-saving actions for lighting, misting, and ventilation • Display bed-level stress and optimization suggestions on a centralized dashboard	• First LoRa-ML system tailored for mid-scale rose greenhouse operations • Enables offline-capable multi-zone stress monitoring and control • Supports zone-specific energy optimization through predictive analytics • Reduces manual labor and energy usage while improving rose health

IT22358448	To pre-detect and alert to diseases in roses by identifying high-risk conditions before infection occurs.	• System Setup: Acquire and integrate the thermal camera and ambient sensors onto the mobile system within the green hut. • Data Collection & Training: Establish a healthy baseline (ΔT), systematically collect and label thermal data sets representing green, yellow, and red health zones, and use this to train and validate the classification model on microcontroller. • Deployment & Alerting: Load the validated model onto the control unit to perform real-time inference during automated scans, triggering an immediate user alert (via notification) if any plant is classified into the Red Zone.	• Prevent diseases (fungus) onset by detecting subtle thermal shifts before visible symptoms appear. • Classifies health zones (Red/Yellow/Green) based on the plant-air temperature difference using an ML model, minimizing human interpretation. • Provides precise alerts for immediate, resource-efficient treatment, reducing the need for broad-spectrum intervention. • Combines T_{leaf} sensing, machine learning, and automated notification into a single, closed-loop system for mid-scale plantation.
IT22326522	To predict and maintain optimal soil nutrient balance (N, P, K, pH, EC, and moisture) in greenhouse rose cultivation through AI–IoT integration, providing precise, stage-based	• Collect real-time soil and environmental parameters • Predict future nutrient behavior using an LSTM-based AI model trained on greenhouse data. • Analyze EC and nutrient trends to detect risks of salinity buildup or deficiency early.	• Uses LSTM to forecast soil nutrients and EC levels in advance. • Adjusts fertilizer advice based on the plant's growth stage. • Consider temperature, humidity, and rain forecasts before fertilizer application.

	fertilizer recommendations for sustainable and efficient fertigation management.	• Generate fertilizer type, dosage, and timing recommendations automatically based on predicted values and plant growth stage. • Integrate weather forecast data.	• Warns farmers about nutrient deficiency or salinity risks before problems occur. • Designed for local coir media, humid climate, and mid-scale rose tunnels.
IT22367594	To monitor, predict and maintain post-harvest rose freshness using IoT sensors and AI technologies that track vase-life factors such as temperature, humidity, ethylene gas, and water level.	• Set up temperature, humidity, water level, and ethylene gas sensors in vase or storage unit. • Send freshness alerts to florists when conditions become unfavorable. • Develop an AI model to predict freshness score and vase life hours. • Automate water replacement and preservative addition when freshness declines.	• First IoT based Smart vase life monitoring system designed for Sri Lankan floriculture. • Uses real time freshness prediction and automatic water management to reduce flower spoilage. • Bridges the post harvest gap between farmers and florists through real time data driven insights.

9. Individual component description of how it is complied with the specialization.

Member Name with Registration No	Description
IT22888648	**Centralized Stress Prediction & Energy Optimization System** This component applies to IoT, AI, and data analytics within the IT specialization. LoRa-enabled sensor nodes collect real-time climate data from multiple greenhouses. A central gateway processes and stores data with offline capability. A machine learning model predicts flower bed stress levels and recommends optimized actuator usage. The system demonstrates skills in sensor networking, predictive modeling, edge-cloud integration, and real-time visualization.
IT22358448	**Automated Early Disease Detection System Using Thermal Imaging** This component demonstrates specialization by focusing entirely on pre-symptomatic disease identification in a controlled greenhouse environment. The system uses a thermal sensor mounted on a mobile system to collect specialized, non-invasive thermal data. The core principle is specialized metric tracking: measuring the difference between plant and air temperature (ΔT), a key indicator of early fungal stress. A dedicated classification model is trained exclusively on this (ΔT) data, making it a highly specialized diagnostic tool. This intelligence results in a specialized output: classifying the plant health into Red, Yellow, or Green zones, allowing for an immediate, targeted intervention that prevents widespread crop damage.
IT22326522	**Intelligent Nutrition Management for Greenhouse Roses** This component integrates multiple core areas of IT specialization, including Internet of Things (IoT), Artificial Intelligence (AI), Data Science, and Software Engineering. Real-time sensor data (NPK, pH, EC, moisture, temperature, humidity) is collected through an IoT network using an ESP32 microcontroller. The data is then analyzed using a machine learning model (LSTM) to predict nutrient and salinity trends and provide fertilizer recommendations (type, dosage, timing). The system also uses API integration to include weather forecasts for optimizing fertilizer scheduling. The mobile dashboard enables farmers to view live readings, forecasts, and alerts applying Human-Computer Interaction (HCI) principles for simplicity and usability.

IT22367594	**IoT Based Freshness Monitoring & Post harvest Management** This component applies IoT system design, cloud integration, data analytics, and AI regression modeling to post harvest rose freshness management. Using sensors such as temperature, humidity, ethylene gas, and water level modules, the system collects real-time environmental data from the smart vase. The software backend processes this data to calculate a freshness score and predict remaining vase life hours through an AI regression model. The system's dashboard visualizes live readings and sends alerts when freshness levels decline, while the automated water control mechanism refills or replaces vase water and adds preservatives when needed. This integrates multiple Information Technology disciplines including IoT architecture, cloud computing, machine learning, embedded programming, and data visualization demonstrating a complete, intelligent, and data driven decision support system for Sri Lankan floriculture.

10. Supervisor details

	Title	First Name	Last Name	Signature
Supervisor	Dr.	Junius	Anjana	[signature] 27/oct/2025
Co-Supervisor	Ms.	Kaushika	Kahatapitiya	[signature] 28/10/2025
External Supervisor				
Summary of external supervisor's (if any) experience and expertise				

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This part is to be filled by the Topic Screening Staff members.

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:

I recommend the revised topic

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Topic Assessment Form

Acceptable: Mark/Select as necessary

Topic Assessment Accepted	
Topic Assessment Accepted with minor changes*	
Topic Assessment to be Resubmitted with major changes*	
Topic Assessment Rejected. Topic must be changed	

* Detailed comments given below

Comments

Staff Member's Name	Signature
Dr. Junius Anjana	[signature] 31/oct/2025
Kaushika Kahatapitiya	[signature] 31/10/2025

*__Important__:

1. According to the comments given by the evaluator, make the necessary modifications and get the approval by the **Evaluator**.
2. If the project topic is rejected, identify a new topic, and request the RP Team for a new topic assessment.