AI-Driven Nutrient Management in Hydroponics for Urban Agriculture
Enhancing Food Security through Technology

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A THESIS

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I certify that I have read this thesis and that in my opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Science.

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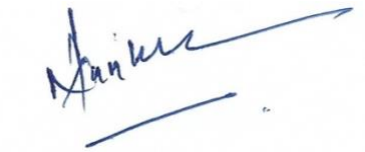
DECLARATION

This is to certify that the work is entirely my own and not of any other person, unless explicitly acknowledged (including citation of published and unpublished sources). The work has not previously been submitted in any form to the Sri Lanka Institute of Information Technology or to any other institution for assessment for any other purpose.



Sign: ……

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Date: 16/01/2025

ABSTRACT

Advancing Urban Agriculture Practices via Integration of Artificial Intelligence into Hydroponics Systems to Enhance Food Security

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This research investigates the integration of artificial intelligence (AI) into hydroponic farming systems to tackle challenges in urban agriculture, particularly food security and resource optimization. Urban expansion and shrinking arable land necessitate innovative agricultural solutions, and hydroponics—a soilless cultivation method—is increasingly recognized for its efficiency and scalability in urban environments. By leveraging AI and Internet of Things (IoT) technologies, this study develops an automated nutrient management system that optimizes critical parameters such as pH, electrical conductivity (EC), and nutrient concentrations (NPK: Nitrogen, Phosphorus, Potassium) to enhance plant growth and resource efficiency.

The experimental design includes two hydroponic systems: an AI-driven system and a manual control setup, both operating under identical conditions. The AI-driven system utilizes real-time sensor data, processed by machine learning models, to automate nutrient adjustments. Data collected from sensors, including pH, EC, and temperature, is transmitted via AWS IoT Core and stored in DynamoDB for real-time monitoring and historical analysis. The system's performance is visualized through an Angular-based dashboard, enabling continuous monitoring and decision-making.

Results demonstrate that the AI-driven system significantly outperforms manual nutrient management in terms of plant growth, resource efficiency, and environmental stability. Plants grown in the automated system exhibited a 48% increase in weight and improved root development compared to those grown in the manual system. The automated system

also maintained optimal pH (6.3–6.7) and EC (1.8–2.4) levels with minimal deviations, reducing nutrient waste and ensuring precise dosing.

This research contributes to the field of smart agriculture by showcasing the transformative potential of AI and IoT technologies in hydroponic farming. The findings emphasize the viability of AI-driven systems to enhance the sustainability, scalability, and efficiency of hydroponics for urban agriculture. The integration of advanced

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This project could not have been completed without various groups providing financial assistance to fund fieldwork and the inclusion of questions on various surveys in 2024. I am especially grateful to the Mahapola Trust, which funded the fieldwork in 2024.

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