Chapter 13
Mechanized Functioning of Tomato and Lettuce Greenhouses Using IoT and Machine Learning Techniques

Shipra Saraswat
ABES Institute of Technology, Ghaziabad, India

Rijwan Khan
https://orcid.org/0000-0003-3354-3047
ABES Institute of Technology, Ghaziabad, India

Ayush Gupta
https://orcid.org/0009-0007-2583-9223
ABES Institute of Technology, Ghaziabad, India

Abhay Mehta
ABES Institute of Technology, Ghaziabad, India

ABSTRACT

This chapter explores the mechanized functioning of tomato and lettuce greenhouses through the integration of internet of things (IoT) and machine learning techniques. It highlights the transformative impact of these technologies on the agricultural industry, enabling enhanced productivity, optimized resource management, and improved crop yield. By leveraging IoT, greenhouses become interconnected systems that allow real-time monitoring and control of environmental parameters. Machine learning (ML) algorithms examine data collected from sensors and historical records to predict crop growth patterns, disease outbreaks, and pest infestations. This enables proactive decision-making and efficient resource allocation. The adoption of IoT in greenhouse farming not only automates operations but also promotes sustainable practices, reducing labor costs and optimizing resource utilization. Overall, this chapter showcases the potential of IoT and ML technologies in revolutionizing greenhouse farming for increased efficiency, sustainability, and food security of tomato and lettuce crops.

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INTRODUCTION

Water and food shortages are getting worse, because of the unchecked global population growth. According to the technical analysis issued in (Contreras et al., 2023), 9.15 billion people will inhabit the planet by the year 2050. This trend drives an increase in food production to meet the needs of a growing global population, which results in a shortage of farmland and a decline in the number of farmers as fewer people choose to engage in farming. A few issues confront agriculture today including the expanding global population, the effects of climate change, stringent market rules, and energy inefficiencies (Guesbaya, et al., 2023). To meet these problems, the hierarchical agricultural production system must be implemented with technology at all stages, which calls for the use of resilient and adaptive management systems. The most well-known facilities that can help to address these issues are greenhouses (Guesbaya, et al., 2023). Greenhouses serve as protective environments for crops, providing optimal conditions for their growth. To ensure the efficient development of plants and fruits, it is essential to employ actuators that regulate crucial factors including air temperature, humidity, and CO2 concentration (Guesbaya, et al., 2023). These actuators play a vital role in maximizing plant growth and yield within the greenhouse setting. This paper reviews the production of lettuce and tomatoes in greenhouses using IOT and Machine Learning (Kochhar and Kumar, 2019). In greenhouses at northern latitudes, additional lighting is utilized to increase the daily light exposure of crops. It is preferred to use the freely available sunshine as much as possible to improve plant growth, production, and quality while minimizing electricity usage of artificial lighting (Mohagheghi and Moallem, 2023). When compared to conventional horticulture light sources like metal halide (MH) and high-pressure sodium (HPS), the development of horticultural light- emitting diodes (LEDs) has facilitated this integration. Here in (Mohagheghi and Moallem, 2023), the crop selected for production was a green mini romaine organic lettuce variety called Dragoon (LATIN NAME: Lactuca sativa). The reason behind this crop was that it was a great performer in a climate-controlled greenhouse environment and suitable to be grown successfully using hydroponic growing methods or other soil-fewer growing systems (Flores et al., 2016). In order to give farmers and automatic controllers the knowledge necessary to choose when to activate greenhouse actuators in order to enhance crop conditions or protect them, this calls for sensors (Mohagheghi and Moallem, 2023). that monitor the evolution of the variables of interest. Smart technologies such as Internet of Things (IoT), using sensors, artificial intelligence devices, smart surveillance and monitoring systems, play a role in overcoming the main challenges in conventional greenhouse farming as mentioned in (Ahmad et al., 2023) such as controlling the local climate of the greenhouse, monitoring the crop growth parameters, and setting the crop harvest time (Chang et al., 2021). In order to automate elements like temperature, humidity, and photoperiod utilizing sensor- based technologies, intelligent greenhouse automation systems should maintain the microclimate using setpoints and protect plants against abrupt changes in the microclimate as mentioned in (Ahmad et al., 2023). These recent advancements in information technology allow traditional greenhouses to use less labor and overcome challenges sustaining microclimatic conditions (Ojha et al., 2015). Tomato (Solanum lycopersicum L.) is one of the most economically important crops in the world and undergoes both vegetative and generative growth (Dubey and Jalal, 2013). Vegetative growth depicts growth of the roots, stems and leaves, and generative growth depicts growth of the flowers and fruits (Dutta et al., 2023). During generative growth, tomato fruits undergo several changes such as increases in their size, color changes, and so on. In reference to (Seo et al., 2021), the paper explores the development of a robotic system designed for real-time monitoring of a substantial volume of tomatoes, focusing on the specific requirements for tomato production. The study delves into the implementation of this system and

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