# Design and Implementation of a Self-Sustaining Greenhouse using Internet of Things

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## Abstract

This study presents an IoT-enabled smart greenhouse that automatically monitors and controls environmental conditions for optimal plant growth. Using Arduino ADK 2560, the system tracks eight key parameters, temperature, humidity, light intensity, soil moisture, water level, rain, dust, and smoke through various sensors. Real-time data is transmitted to the Blynk app via ESP8266 module, allowing remote monitoring. The system automatically activates water pumps, sprinklers, and ventilation shutters based on preset thresholds. Powered by solar energy, this self-sustaining approach reduces human intervention while improving resource efficiency and crop yields.

**Keywords**. IoT, Greenhouse, Self-sustainable, Wireless Sensor Network, Agriculture.

## 1. INTRODUCTION

Greenhouse farming traditionally required constant human effort to maintain perfect growing conditions. The emergence of Wireless Sensor Networks (WSNs) has revolutionized this by enabling intelligent, self-sustaining agriculture [1]. Through strategically placed sensors monitoring eight critical parameters, temperature, humidity, light intensity, and soil moisture, farmers gain real-time visibility into their crops' environment [2]. This data-driven approach forms the foundation of modern smart farming, where conditions are automatically optimized for specific plants. By integrating Internet of Things (IoT) technology, manual control transforms into automated response systems that maintain ideal conditions without human presence [3]. This seamless combination of WSNs and IoT empowers farmers with precise, data-based cultivation techniques that adapt to both indoor and outdoor environmental changes [4, 5].

## 2. SYSTEM ARCHITECTURE

The proposed self-sustaining greenhouse operates through an integrated automatic system built around the Arduino ADK 2560 microcontroller. The setup continuously monitors eight critical environmental parameters using different sensors placed both inside and outside the greenhouse structure. Inside the greenhouse, soil moisture levels are tracked using YL-69 sensors while temperature, humidity, and light intensity are measured through HT-CdS sensors. An ultrasonic sensor keeps watch over water tank levels to ensure uninterrupted irrigation supply. Outside the greenhouse, rain sensors and dust/smoke detectors monitor external conditions that could potentially harm the crops. The system follows a simple yet effective working principle where sensor readings are constantly compared against pre-set threshold values stored in the Arduino program. When any parameter falls outside the desired range, the controller automatically activates the necessary response mechanisms without requiring human intervention. For instance, if soil moisture drops below 50%, the irrigation system turns on, and when water tank levels go below 40cm, the water pump starts refilling until it reaches 90cm. All sensor data gets transmitted in real-time to the Blynk mobile application through an ESP8266 Wi-Fi module, allowing farmers to monitor their greenhouse conditions remotely from anywhere. The entire prototype runs on solar power with battery backup, making it truly self-sustainable. Testing results confirmed that all sensors performed accurately according to their threshold settings, successfully controlling the actuators representing sprinklers, shed covers, and water pumps. The system effectively maintains optimal growing conditions by automatically responding to changes in soil moisture, rain detection, dust levels, and water availability. This integrated approach demonstrates how automation can replace manual monitoring while improving resource efficiency and crop protection. The automated process is explained with the help of the flow chart portrayed in Figure 2.1.

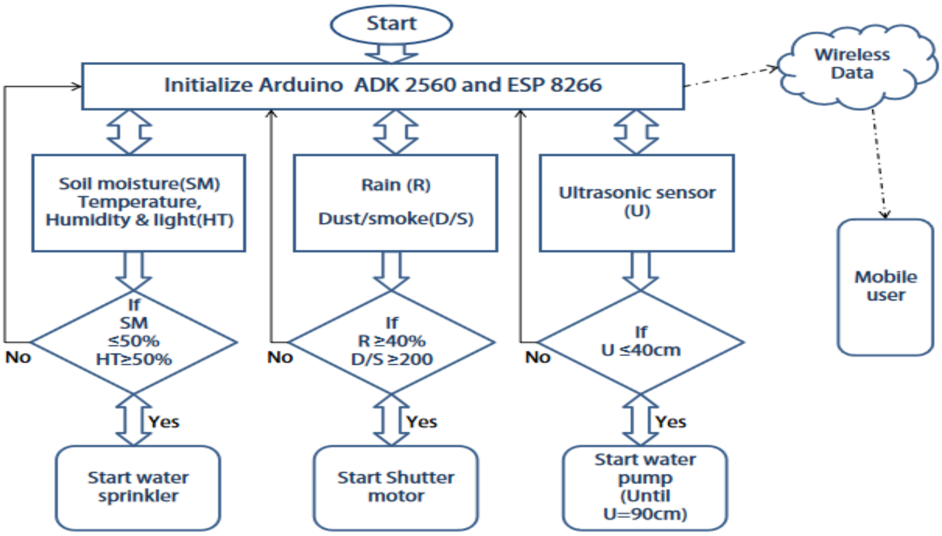


Figure 2.1. Flowchart of Prototype.

## 3. RESULTS AND DISCUSSION

The proposed self-sustaining greenhouse system successfully monitored and controlled eight environmental parameters through its sensor network. The Arduino ADK 2560 continuously processed data from all sensors and triggered appropriate responses based on programmed threshold values. The system demonstrated effective environmental control through automated actuator responses. When soil moisture dropped below 50%, the irrigation system activated until optimal moisture levels were restored. Similarly, the retractable shutter mechanism responded to outdoor conditions, protecting crops during rainfall when sensor readings exceeded 40% and during high pollution events when dust particle concentration crossed 200 µg/m³ [1]. Water management was automated using an ultrasonic sensor that maintained tank levels between 40cm and 90cm, ensuring continuous irrigation supply [2]. Temperature, humidity, and light intensity remained under constant monitoring, providing real-time growing condition data [3]. The integration of renewable energy through solar panels made the system truly self-sustaining, with battery backup ensuring uninterrupted operation. Remote monitoring via the Blynk application allowed farmers to track all parameters from anywhere, eliminating the need for constant physical presence [4]. The automated system successfully replicated the decision-making process of human operators while responding faster to environmental changes. This approach to greenhouse management demonstrates how IoT technology can optimize growing conditions, reduce resource consumption, and minimize human intervention in agricultural operations [5].

## 4. CONCLUSION

This research successfully developed an Arduino-based self-sustaining greenhouse system that automatically monitors and controls eight environmental parameters. The prototype effectively manages soil moisture, temperature, humidity, light, water levels, rain, and air quality without human intervention. By maintaining optimal growing conditions, such systems can boost crop yields by up to 40% compared to traditional methods. This affordable, automated solution offers farmers a practical way to protect valuable crops while reducing water and energy waste.

## 5. REFERENCES


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## Biographies

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