

# Automatic Green House Monitoring System

Prof. A. S. Rane<sup>1</sup>, Mr. Aditya Mansute<sup>2</sup>, Mr. Swapnil Thakare<sup>3</sup>, Mr. Pratik Thakare<sup>4</sup>, Mr. Ganesh Gorale<sup>5</sup>, Mr. Sujit Kolte<sup>6</sup>

Professor, Department of Electrical Engg, Dr. V. B. Kolte College of Engineering, Malkapur, India<sup>1</sup>  
Students, Department of Electrical Engg, Dr. V. B. Kolte College of Engineering, Malkapur, India<sup>2,3,4,5,6</sup>

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## ABSTRACT

*Agriculture plays a vital role in the economy, and the productivity of crops largely depends on environmental conditions such as temperature, humidity, soil moisture, and light intensity. Traditional greenhouse monitoring methods require constant human supervision and lack real-time data analysis, leading to inefficient resource utilization. To overcome these challenges, this project presents a Raspberry Pi Pico based IoT Greenhouse Monitoring System that enables continuous monitoring and remote supervision of greenhouse parameters. The proposed system uses various sensors to measure temperature, humidity, soil moisture, and light intensity inside the greenhouse. These sensors are interfaced with the Raspberry Pi Pico microcontroller, which collects and processes the sensor data. The processed data is then transmitted to a cloud platform using an IoT communication module, allowing users to monitor greenhouse conditions in real time through a web or mobile application. When the environmental parameters deviate from predefined threshold values, alerts are generated to notify the user, enabling timely corrective actions. This system helps in optimizing water usage, improving crop yield, and reducing manual effort by providing automated and real-time monitoring. The low cost, compact size, and energy efficiency of the Raspberry Pi Pico make the system suitable for small- and medium-scale greenhouse applications. Overall, the proposed IoT-based greenhouse monitoring system enhances agricultural productivity by ensuring a controlled and efficient growing environment.*

**Keywords:** - Raspberry Pi Pico, Internet of Things (IoT), Greenhouse Monitoring, Temperature and Humidity Sensor, Soil Moisture Sensor, Light Intensity etc.

## 1. INTRODUCTION

Agriculture is one of the most important sectors for ensuring food security and economic stability. With the rapid increase in population and the growing demand for high-quality agricultural products, there is a strong need for efficient and sustainable farming practices. Greenhouse cultivation is widely adopted to provide a controlled environment for plants, protecting them from adverse weather conditions and enabling year-round crop production. However, maintaining optimal environmental conditions inside a greenhouse requires continuous monitoring and timely control, which is difficult to achieve using conventional manual methods. Traditional greenhouse monitoring systems depend heavily on human intervention, making them time-consuming, labor-intensive, and prone to errors. Parameters such as temperature, humidity, soil moisture, and light intensity directly affect plant growth and yield.

This leads to efficient resource utilization, reduced operational costs, and improved crop quality. The Raspberry Pi Pico, powered by the RP2040 microcontroller, is a low-cost, compact, and energy-efficient platform that is well suited for IoT-based applications. Its flexibility, low power consumption, and ease of interfacing with various sensors make it an ideal choice for greenhouse monitoring systems. In this project, the Raspberry Pi Pico is used to collect data from environmental sensors and transmit the information to an IoT platform for real-time visualization and analysis. The proposed Raspberry Pi Pico Based IoT Greenhouse Monitoring System aims to continuously monitor critical greenhouse parameters such as temperature, humidity, soil moisture, and light intensity. The system provides real-time data access and alerts when conditions exceed predefined limits, helping farmers take timely action. By automating greenhouse monitoring and enabling remote supervision, this project contributes to smarter agriculture, higher crop yield, and sustainable farming practices.

### 1.1 OBJECTIVE

- Design Real-time Monitoring: To continuously measure key environmental parameters such as temperature, humidity, soil moisture, and light intensity inside the greenhouse.
- Design Remote Access: To enable farmers or greenhouse operators to access environmental data from anywhere using a smart phone, tablet, or computer via the internet.
- Design Automated Control: To automatically operate devices such as fans, heaters, sprinklers, and lights based on sensor readings, ensuring optimal conditions for plant growth.

- Design Efficient Resource Utilization: To minimize wastage of water, electricity, and other resources through precise and timely control actions.

## 2. LITERATURE SURVEY

- **R. Oliveira & H. Chen (2019) et al.** Presents battery-powered sensor nodes using LoRa WAN for long-range, low-power telemetry. Focuses on periodic reporting for climate monitoring and uses a local gateway to trigger irrigation via SMS. Benefits include long battery life and reduced wiring; limitations: low data rates unsuitable for image-based disease detection and potential duty-cycle issues in high-sample-rate needs.
- **M. Al-Turki (2021) et al.** Argues for shifting control algorithms to edge gateways to avoid cloud latency. Implements local PID and anomaly detection on an ARM-based gateway, while cloud handles historical analytics. Shows reduced actuator latency and improved resilience to internet outages. Recommends hybrid designs combining edge for safety-critical loops and cloud for heavy analytics.
- **J. Park & S. Lee (2020) et al.** Compares ARIMA, random forest, and LSTM models for short-term temperature/humidity forecasting using IoT time series. LSTM performs best for non-linear dynamics; authors propose forecast-driven control (pre-ventilation) to smooth climate swings. Notes requirement of extensive labeled data and computational cost for deep models, suggesting transfer learning for new sites.
- **A. Banerjee (2018) et al.** Integrates EC (electrical conductivity), pH, soil moisture sensors and flow sensors to control fertigation. Cloud-based nutrient scheduling uses crop growth stage rules and real-time sensor feedback. Trials show more consistent nutrient delivery and reduced nutrient wastage. Points out sensor fouling and calibration as practical hurdles.
- **E. Morales & D. Sun (2019) et al.** Uses cameras at canopy level to detect leaf spot and early blight via CNNs running on an edge GPU; detections are sent via MQTT to the farm management dashboard to trigger localized fungicide application. Demonstrates high detection accuracy in controlled datasets; challenges include variable lighting, occlusions, and the need for labeled datasets across crops.

## 3. WORKING & IMPLEMENTATION

This project is designed to monitor and control the greenhouse environment using IoT and Arduino. Four sensors are used to detect the temperature, light, humidity, and soil moisture inside the greenhouse. The temperature sensor detects the temperature, and if it goes above or below the threshold value, a signal is sent to the microcontroller. The microcontroller is connected to relays, and one of them is connected to a blower to turn on the fan if necessary. The light sensor detects the amount of sunlight, and if it is above the threshold value, a signal is sent to the microcontroller to turn on the relay that would reduce the amount of sunlight. Similarly, the humidity sensor and soil moisture sensor are used to detect the humidity level and soil moisture, respectively. If the humidity value or soil moisture decreases, the microcontroller would turn on a DC motor in place of a blower and water outlet to decrease the humidity or increase the soil moisture. Data from these sensors are sent to the IoT module (ESP8266) at regular intervals, and the ESP8266 chip is used to connect the microcontroller to the Wi-Fi network and send data. It also allows TCP/IP connections to be made. The project requires a Wi-Fi module to be connected to a Wi-Fi zone or hotspot. In the absence of the IoT module, a GSM module can be used to trigger an SMS. This project is user-friendly, low-cost, and can be easily implemented, making it ideal for greenhouse monitoring and control using IoT and Arduino technology.

## 4. CONCLUSIONS

The Raspberry Pi Pico Based IoT Greenhouse Monitoring System successfully demonstrates an efficient and cost-effective solution for monitoring environmental conditions inside a greenhouse. By continuously measuring key parameters such as temperature, humidity, soil moisture, and light intensity, the system ensures that plants are grown under optimal conditions. The integration of IoT technology enables real-time data transmission to a cloud platform, allowing users to remotely monitor greenhouse conditions and make timely decisions. This project reduces the dependency on manual monitoring, minimizes human error, and promotes efficient use of resources such as water and energy. The use of the Raspberry Pi Pico makes the system compact, low power consuming, and economical, making it suitable for small- and medium-scale agricultural applications. Additionally, the alert mechanism helps in preventing crop damage by notifying users when environmental parameters cross preset threshold values. Overall, the proposed system enhances productivity, improves crop quality, and supports sustainable farming practices. With further enhancements such as automatic control of irrigation, ventilation, and lighting systems, the project can be extended into a fully automated smart greenhouse, contributing significantly to the advancement of modern precision agriculture.

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