SMART IOT SYSTEM FOR LEAFY VEGETABLE STORAGE

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Problem Statement

Vegetables stored in warehouses are highly sensitive to environmental conditions such as temperature and humidity. Improper storage conditions may lead to spoilage and economic loss. Additionally, unauthorized access to storage areas outside working hours can compromise product safety and quality.

Analytics and Decision Logic

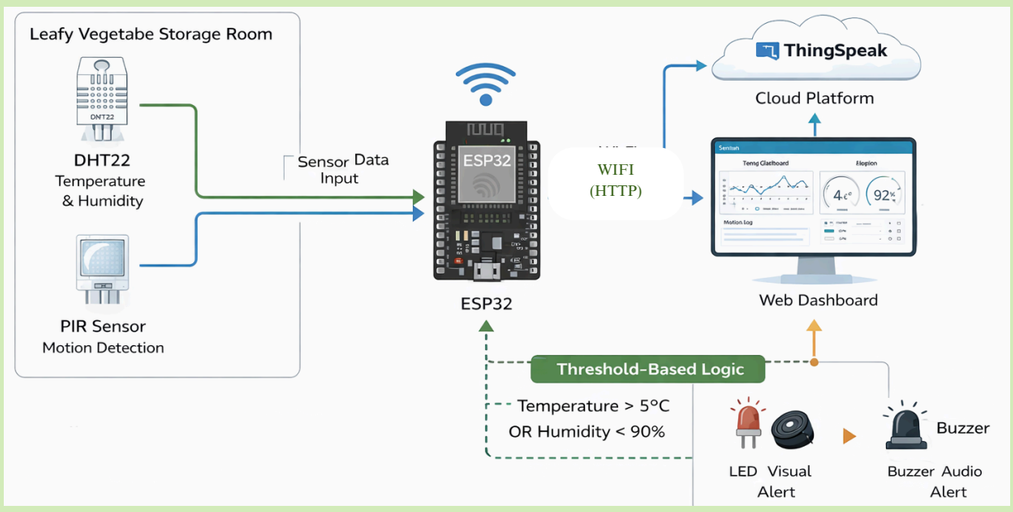
Data Flow:

Sensors → ESP32 → Alerts
↘
WiFi → ThingSpeak → Dashboard

System Architecture

The system consists of environmental sensors connected to an ESP32 microcontroller. Sensor data is transmitted via WiFi to a cloud platform for storage, visualization, and analysis.

Alert devices are activated automatically based on predefined decision logic.



Results and Observations

- Real-time sensor data successfully uploaded to the cloud.
- Live visualization achieved using ThingSpeak dashboards.
- Alert system responded correctly to abnormal conditions.
- System performed reliably during testing.

ESP32-based physical hardware prototype with DHT11, PIR sensor, LED, and buzzer

Hardware Implementation

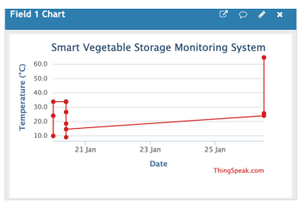
The physical hardware prototype is built using an ESP32 microcontroller integrated with a DHT11 temperature and humidity sensor and a PIR motion sensor.

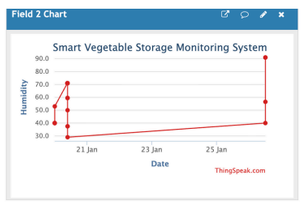
Visual and audio alerts are provided using an LED and a buzzer, which are activated automatically based on the decision logic implemented on the ESP32.

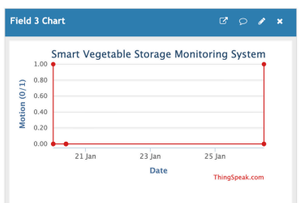
Power & Connections

- DHT11 powered at 5V
- PIR sensor powered at 5V
- All components share a common ground

ThingSpeak graphs







Real-time temperature, humidity, and motion data are visualized using ThingSpeak dashboards. The graphs show successful sensor readings and data transmission, confirming proper system functionality.

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Objectives

01 Monitor temperature and humidity inside the vegetable storage area.

02 Detect motion during non-working hours.

03 Send real-time sensor data to a cloud platform.

04 Visualize data using an online dashboard.

05 Trigger automatic alerts under abnormal conditions.

Hardware and Sensor Configuration

Hardware Components:

- ESP32 Microcontroller
- DHT22 Temperature & Humidity Sensor
- PIR Motion Sensor
- LED
- Buzzer

Pin Connections:

- DHT22 DATA → GPIO 15
- PIR OUT → GPIO 27
- LED → GPIO 4
- Buzzer → GPIO 26

Cloud / Data Pipeline Architecture

ThingSpeak is used as the cloud platform for data storage and visualization. Sensor readings are sent from the ESP32 to the cloud using HTTP GET requests over WiFi.

Cloud Fields:

- Field 1: Temperature (°C)
- Field 2: Humidity (%)
- Field 3: Motion Status (0 / 1)

Analytics and Decision Logic

The system applies threshold-based analytics to enable autonomous operation.

Decision Rules:

- If temperature > 30 °C → Alert activated
- If humidity > 80 % → Alert activated
- If motion is detected between 12:00 AM and 6:00 AM → Alert activated

Sample Serial Log:

Temp: 24.0 °C | Humidity: 40 % | Motion: 0

Security and Privacy Considerations

- Cloud communication is protected using a private API key
- No personal or sensitive data is collected
- Only environmental and motion data are transmitted

Conclusion and Future Enhancements

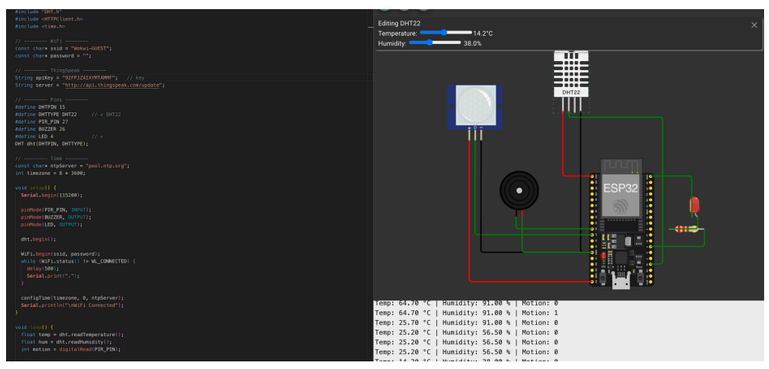
Conclusion:

The project demonstrates a functional IoT-based vegetable storage monitoring system that integrates sensors, cloud computing, analytics, and automated alerts to improve storage conditions and security.

Future Enhancements:

- Mobile notifications.
- Machine learning-based spoilage prediction.
- Additional sensors such as gas or air quality sensors.

Wokwi simulation



The Wokwi simulation uses a DHT22 sensor due to simulator availability, while the physical hardware prototype uses a DHT11 sensor. Both sensors provide temperature and humidity measurements and follow the same system logic.