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IOT-Based Cold Storage Monitoring and Controlling System

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Abstract: The increasing demand for high-quality and safe food products across global supply chains has intensified the need for an efficient cold storage monitoring systems. Traditional monitoring methods rely on manual inspection, which is prone to errors, delays, and inconsistencies that often lead to spoilage, financial losses, and compromised food safety. To address these challenges, this project proposes an Internet of Things (IoT)-based cold storage monitoring system designed to provide continuous, real-time tracking of environmental conditions, including temperature, humidity, and gas concentration. The system which integrates ESP32 microcontroller technology with a suite of sensors, cloud connectivity, and analytics to ensure accurate data acquisition, fast communication, and automated alerts. The proposed system collects sensor data at the regular intervals, processes it locally, and transmits it to a cloud server using Wi-Fi and lightweight communication protocols such as MQTT or HTTP.A user-friendly dashboard enables remote visualization of real-time parameters, historical trends, and system alerts, contributing to improved decision-making and operational efficiency. Additionally, data analytics support anomaly detection, predictive maintenance, and optimization of the cold storage performance. This report presents the project's conceptual framework, literature review, system design, methodology, and key technological components. It identifies the research gaps in existing solutions and highlights the significance of an IoT-enabled approach for enhancing preservation, reducing post-harvest losses, and ensuring supply chain transparency. The proposed system aims to deliver a cost-effective, scalable, and intelligent cold storage monitoring solution that aligns with the modern industry requirements, contributing to improved food safety and sustainability throughout the supply chain.

I. INTRODUCTION

The modern food supply chain relies heavily on the effective cold storage systems to maintain the quality, safety, and shelf life of perishable products, including fruits, vegetables, dairy, meat, and pharmaceuticals. With the increasing consumer demand, globalization of trade, and stringent food safety regulations, ensuring consistent environmental conditions within the cold storage facilities has become more critical than ever.

However, the traditional monitoring methods that rely on manual inspection are often slow, inaccurate, and insufficient for detecting rapid fluctuations in temperature or humidity. Cold chain management is the critical pillar of modern supply chains. Maintaining the "thermal integrity" of products—from vaccines to fresh produce—is essential for safety and quality. Current challenges include manual monitoring errors, delayed responses to equipment failure, and high energy costs.

This research proposes an IoT-Based Cold Storage Monitoring System that moves beyond the simple logging. By integrating automation (RFID-based settings) and safety (fire and door alerts), the system creates a holistic environment for sensitive inventory.

II. LITERATURE REVIEW

M. Mohammed et al.[1] propose a multi-sensor IoT architecture for remote cold storage monitoring, integrating temperature, humidity, CO_2, ethylene, and light sensors. The system uses ESP8266 and cloud platforms for real-time data acquisition, energy profiling, compressor monitoring, and automatedalerts. Their experiment on fruit storage demonstrates improved quality retention using IoT-enabled control, showing the reduced fluctuations and early detection of faults, such as compressor overload and gas accumulation. The study strongly highlights the importance of multi-parameter sensing and ThingSpeak-basedanalyticsforpredictiveinsights.

This research directlyaligns with the proposed system, as it emphasizes the cloud-based dashboards, threshold alerts, and energy optimization for reliable cold chain management.

Y. Jalajakshi et al. [2] present an Arduino- and ESP8266-based IoT monitoring system focused on maintaining food quality by tracking temperature, humidity, ethanol gas, and light levels.

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12 Data is transmitted to cloud platforms through Wi-Fi for real-time supervision. The system emphasizes low-cost sensor integration (MQ3, LDR, DHT11) and demonstrates how atmospheric parameters affect food spoilage. The paper emphasizes the importance of online monitoring, eliminating the need for physical presenceandtherebyreducingmanpowerrequirements in storage facilities. The system's block diagram and circuit description illustrate a simple yet effective IoT architecture suitable for small and medium-scale cold stores. The findings support the relevance of IoT for reducing food waste and strengthening food safety.

M. Dobaleet al.[3] design an IoT-enabled system focusing on banana storage and ripening control using NodeMCU ESP8266. They monitor temperature, relative humidity, and ethylene gas concentration, which are crucial for banana ripening. Sensor data is logged on the cloud, enabling remote alerts and decision-making. Their application also includes preventive maintenance features, where freezer performance is tracked to predict early failures based on temperature history. The study emphasizes the benefits of integrating cloud analytics and mobile notifications (SMS, Whatsapp, email) to ensure rapid response. This paper is highly relevant to the current project, as it supports remote monitoring, cloud connectivity, and gas-level sensing for effective cold chain control. A. Yunus Cil et al.

[4] Present a comprehensive IoT-based solution for monitoring refrigerated containers in port logistics. UsingWSN(IEEE802.15.4),RFID,andGSMgateways, the system tracks temperature and humidity in real-time and provides alerts when thresholds are exceeded. A decision support module estimatesproduct shelf life using historical sensor data. Ports in Rotterdam, Hamburg, and Valencia are cited as early adopters of IoT-driven logistics. The scalability of the system in high-volume environments, such as ports, highlights IoT's applicability to large supply-chain ecosystems. This study highlights the importance of cloud based monitoring and WSN integration in maintaining cold chain integrity during transportation and storage.

III. METHODOLOGY

The system is built on the modular architecture consisting of a sensing layer, a processing layer, and a communication layer.

A. Hardware Components

1) Microcontroller: Acts as the central hub (e.g., ESP32 or Arduino with Wi-Fi) to process the sensor data.
2) DHT22 Sensor: Utilized for high-precision temperature and humidity tracking to achieve more accuracy to avoid any consequences.
3) RFID Reader (MFRC522): Scans product tags/QR codes to automatically adjust the cooling setpoints based on the specific requirements of the item (e.g., meat vs. fruits).
4) GSM Module (SIM800L): Provides redundancy by sending SMS alerts in areas with poor internet connectivity or during Wi-Fi outages to prevent damages.
5) Power Sensor (SCT-013): Monitors current and voltage to track energy efficiency to minimize the power consumption.
6) Safety Sensors: IR/Magnetic reed switches for door monitoring and Flame/Smoke sensors for fire detection to avoid accidents.

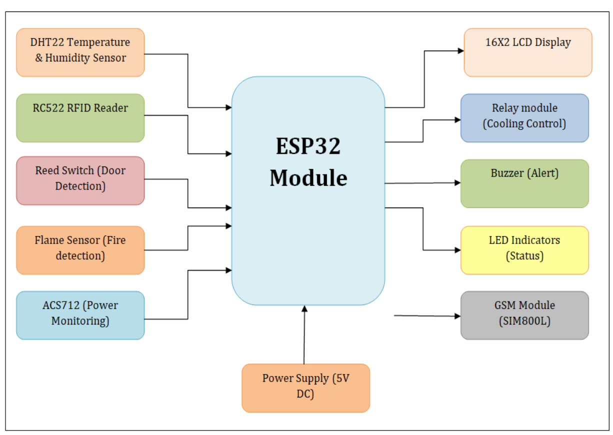


Figure 1: Block Diagram

B. Functional Workflow

The system operates on the feedback loop. The microcontroller compares real-time sensor data against the RFID-defined threshold. If the temperature exceeds the limit, a Relay Module triggers the cooling unit.

IV. IMPLEMENTATION FEATURES

1) Automated Environmental Control: Unlike static systems, the inclusion of RFID-based product selection allows the system to be "commodity-aware." When a user swipes an RFID tag associated with a specific product, the system updates the T max and Hmax variables in the code logic.
2) Safety and Security Fire Detection: Upon detecting a flame signature, the system immediately cuts power to the cooling unit (to prevent electrical feeding of the fire) and triggers the GSM SMS.
3) Door Monitoring: Prolonged "Door Open" states trigger a buzzer, preventing energy loss and temperature spikes.
4) Power Consumption Tracking: By calculating the real-time wattage $P=V\times I$, the system logs energy usage patterns, allowing facility managers to identify failing hardware that may be drawing excess current.

V. RESULTS

Preliminary testing indicates the high correlation between the sensor accuracy and laboratory-grade thermometers. The GSM latency for the SMS alerts was recorded at an average of 4.5 seconds, ensuring rapid human intervention.

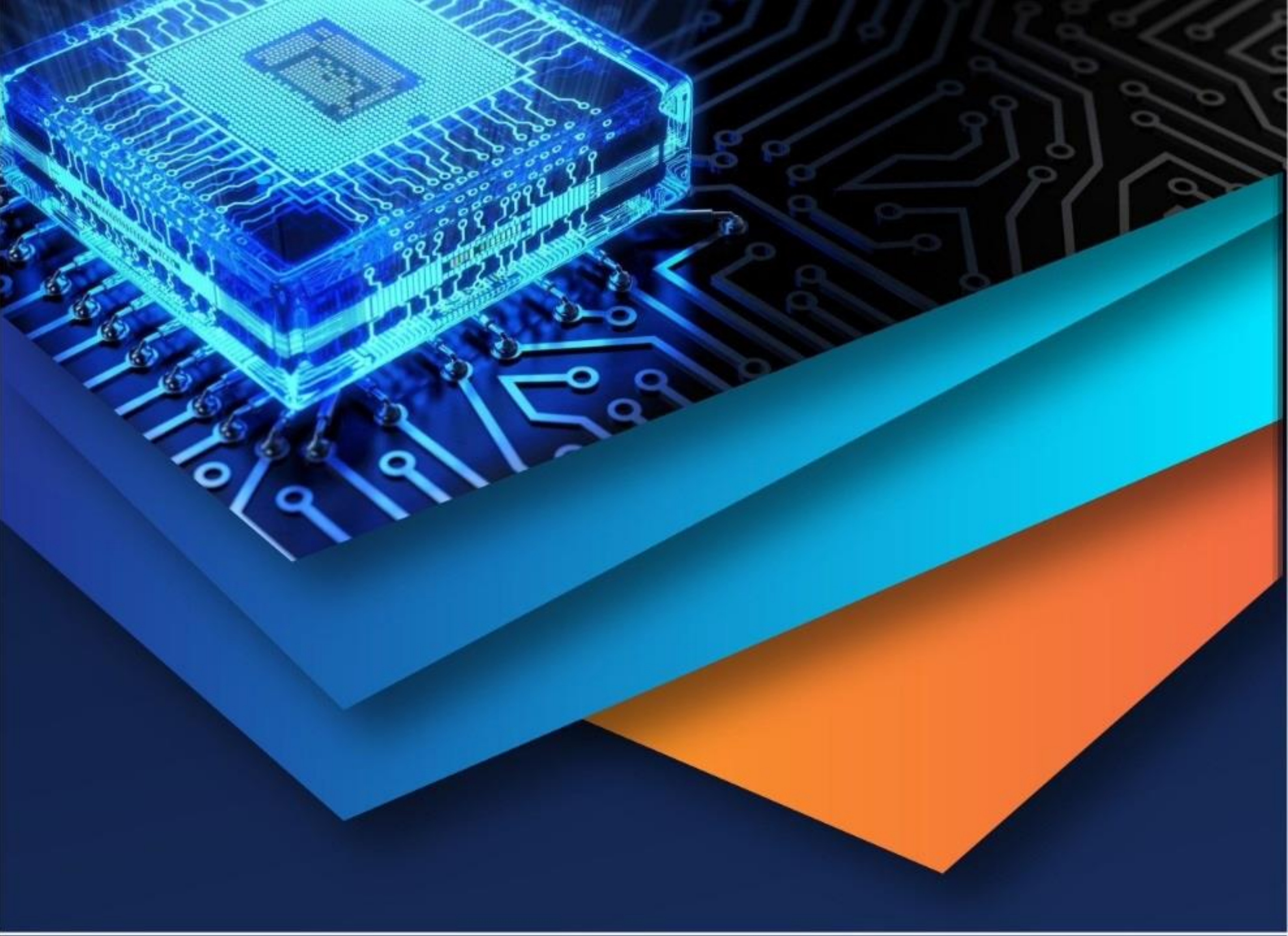
Key Observation: The automated cooling control reduced manual intervention by 85%, and the RFID integration eliminated human error in setting the storage temperatures for different inventory types.

VI. CONCLUSION

The developed IoT-based Cold Storage Monitoring System provides the comprehensive solution for modern warehouse management. By combining the real-time IoT telemetry with the reliability of GSM alerts and the intelligence of RFID, the system ensures product longevity and operational safety. Future iterations could involve the Machine Learning (ML) algorithms to predict hardware failure based on the power consumption anomalies.

REFERENCES

[1] P. Budhathoki, P. D. Magar, and S. K. Pandey, “REVIEW ON POST-HARVEST HANDLING OF FRUITSANDVEGETABLESTOMINIMIZE LOSS,” Food.agr.manag.,vol.2, no.1,pp.37–40,Jan.2022,doi: 10.26480/faer.01.2022.37.40.
[2] K. Chen et al., “Moisture loss inhibition with biopolymer films for preservation of fruits and vegetables: A review,” International Journal of Biological Macromolecules, vol. 263, no. Pt 1, p. 130337, Feb. 2024, doi:10.1016/j.ijbiomac.2024.130337.
[3] Mrs. C. Radha, Mr. M. M.Althaf, Mr. M. Lokesh, andMr.M.Madheswaran,“EnvironmentalMonitoring in Internet of Things (IOT),” IJRASET, vol. 12, no. 4,
[4] pp. 1658–1663,Apr. 2024, doi:10.22214/ijraset.2024.60086.
[5] G. S. K. Yadav, “Environmental Monitoring and Control System of Green House with Microcontroller and GSM Using IoT Devices,” IJSREM, vol. 08, no. 04, pp. 1–5, Apr. 2024, doi: 10.55041/ijsrem31098.
[6] M. Mohammed, K. Riad, and N. Alqahtani, “Design of a Smart IoT-Based Control System for Remotely Managing Cold Storage Facilities,” Sensors, vol. 22, no. 13, p. 4680, June 2022, doi: 10.3390/s22134680.



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