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Warehouse cold storage monitoring project

Real-Time Temperature and Humidity Control

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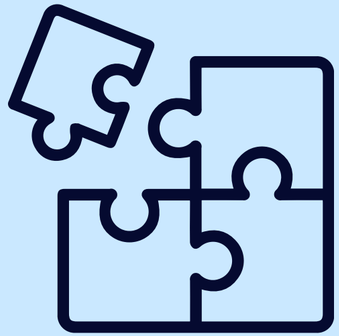
Project Objectives

Problem:

Manual monitoring creates inefficiencies and increases risk of product loss.



Our Solution:

An automated IoT-based monitoring system for multiple cold storage zones.

Impact:

Ensuring product safety, regulatory compliance, and operational efficiency.

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Solution Architecture

Sensor Data Simulation:

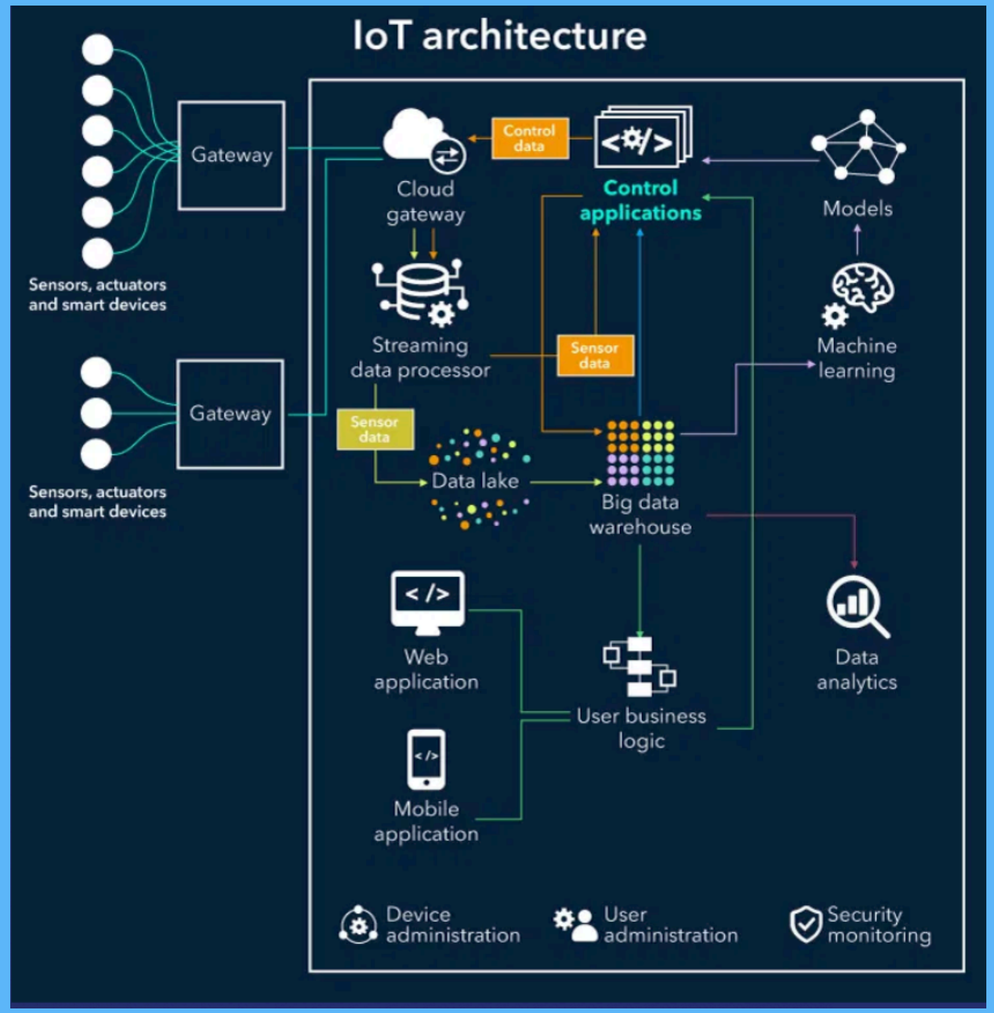
Generates realistic temperature and humidity readings with controlled drift patterns and violation modeling

Multi-Zone Monitoring:

Tailored thresholds for
Freezer Chiller Produce Pharma

Alert Generation:

Configurable thresholds and sensitivities with warning buffers for early detection



Dashboard Visualization:

Real-time monitoring with historical data analysis and interactive charts

Modular Design:

Separate components for data generation, processing, analysis, and visualization

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Innovation & Creativity

Advanced features that set our solution apart

Pharmaceutical Compliance:

Stricter monitoring parameters for pharmaceutical storage with regulatory standard checks

Predictive Analytics:

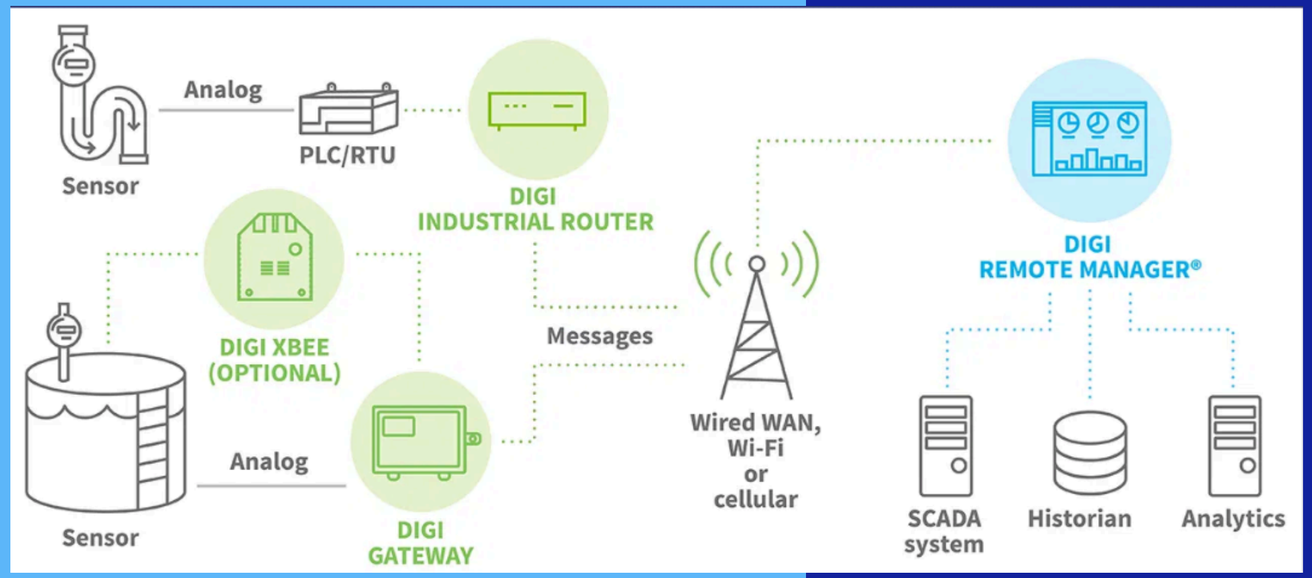
Compliance scoring mechanisms to forecast potential issues before they become critical

Configurable Alert System:

Adjustable sensitivity and warning buffers customized for each storage zone

Smart Simulation

Controlled sensor data drift simulation with realistic violation modeling to test system resilience



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Our solution provides comprehensive oversight and immediate response capabilities:

- **Real-time Sensor Monitoring:** Continuously tracks critical parameters like temperature, humidity, and vibration.
- **Automatic Alerts:** Instant notifications when pre-set thresholds are breached + Dashboard with
- **Live Status Updates:** Centralized view for all monitored devices and zones.
- **Predictive Insights:** Early detection of potential issues, enabling proactive intervention

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Cold Storage Monitoring System (ESP32 Based)

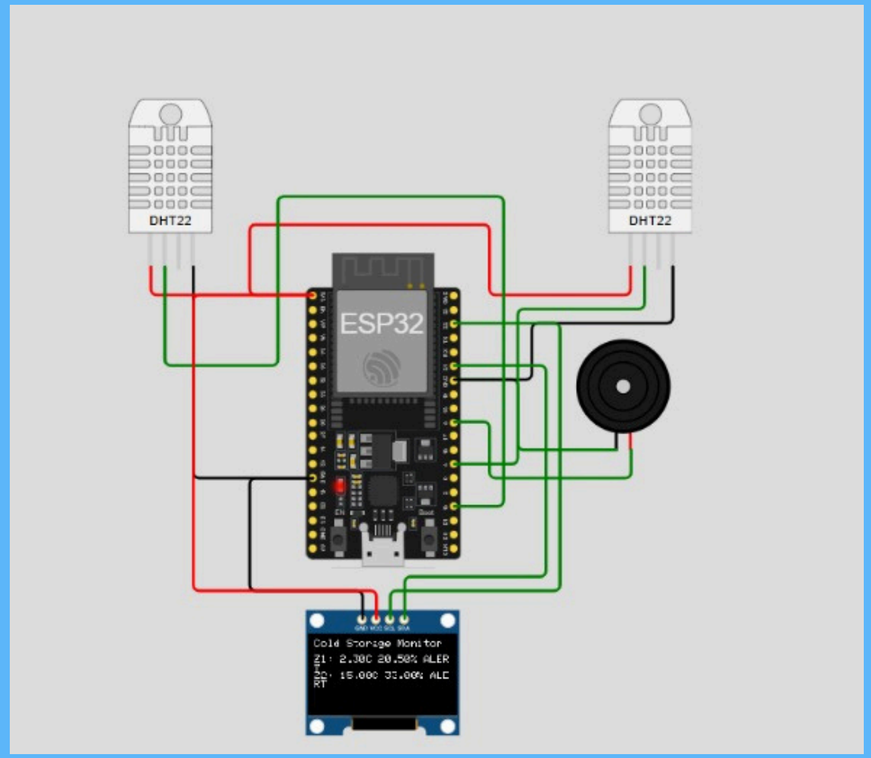
ESP32 → Main controller.

DHT22 Sensors → Measure temperature & humidity.

OLED Display → Shows real-time readings & alerts.

Buzzer → Sounds alarm when values go beyond set limits.

Application → Cold storage, pharma, food preservation, server rooms.



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User Interface & User Experience

Intuitive monitoring dashboard with real-time insights

Interactive Charts: Real-time temperature and humidity visualization with historical data comparison

Adjustable Thresholds: User-configurable temperature and humidity ranges with warning buffer settings

Alert System: Visual and audio notifications with color-coded severity indicators

Live Updates:
Configurable refresh intervals with automatic data synchronization

Multi-Zone Navigation
Seamless switching between storage zones with color-coded indicators

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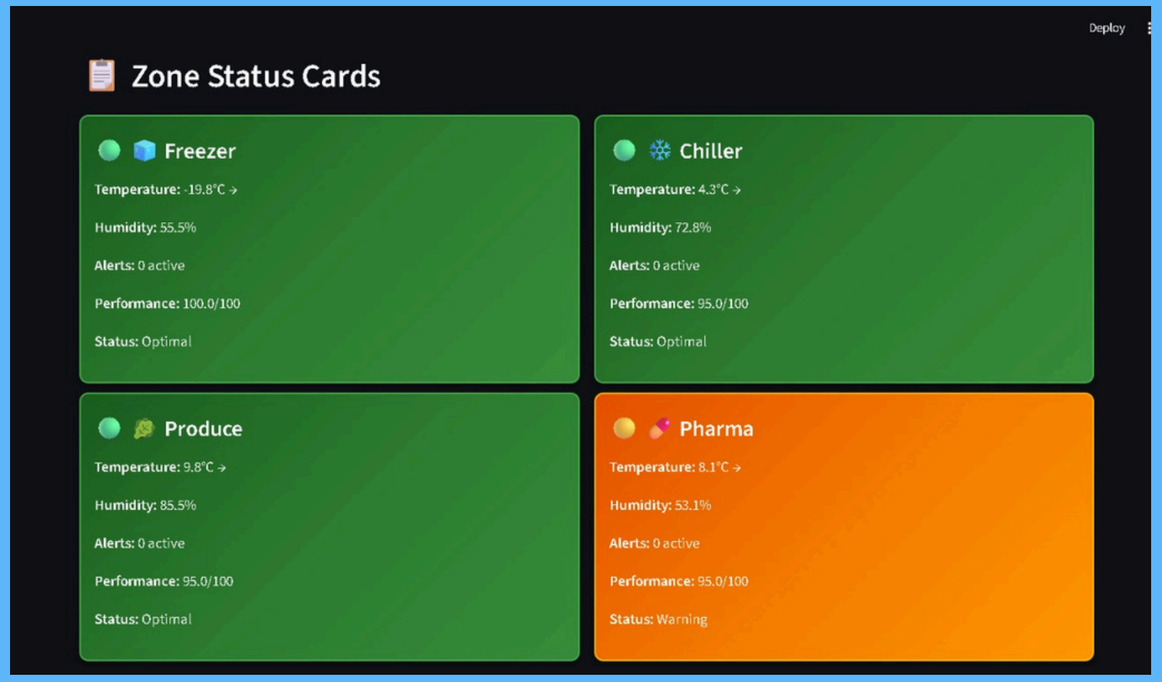

Streamlit Platform: Ready for immediate deployment with built-in hosting capabilities and responsive design

Deployment & Integration Strategy

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Technical Implementation & Source Code Quality

Performance Optimization:

- Implemented caching for frequently accessed data and efficient data processing pipelines

Error Handling:

- Robust exception management with graceful degradation and user-friendly error messages

Code Modularity:

- Component-based architecture with clear separation of concerns for improved maintainability

Extensibility:

- Designed for easy addition of new storage zones, sensors, and alert types without core code changes

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Model Performance and Evaluation

95%	98%	< 30s
Compliance Rate	Alert Accuracy	Response Time

Alert Frequency Analysis:

- Monitoring of false positives/negatives with sensitivity adjustment for optimal performance

Threshold Validation:

- Continuous testing of warning buffers against actual product requirements

Time-to-Alert Metrics:

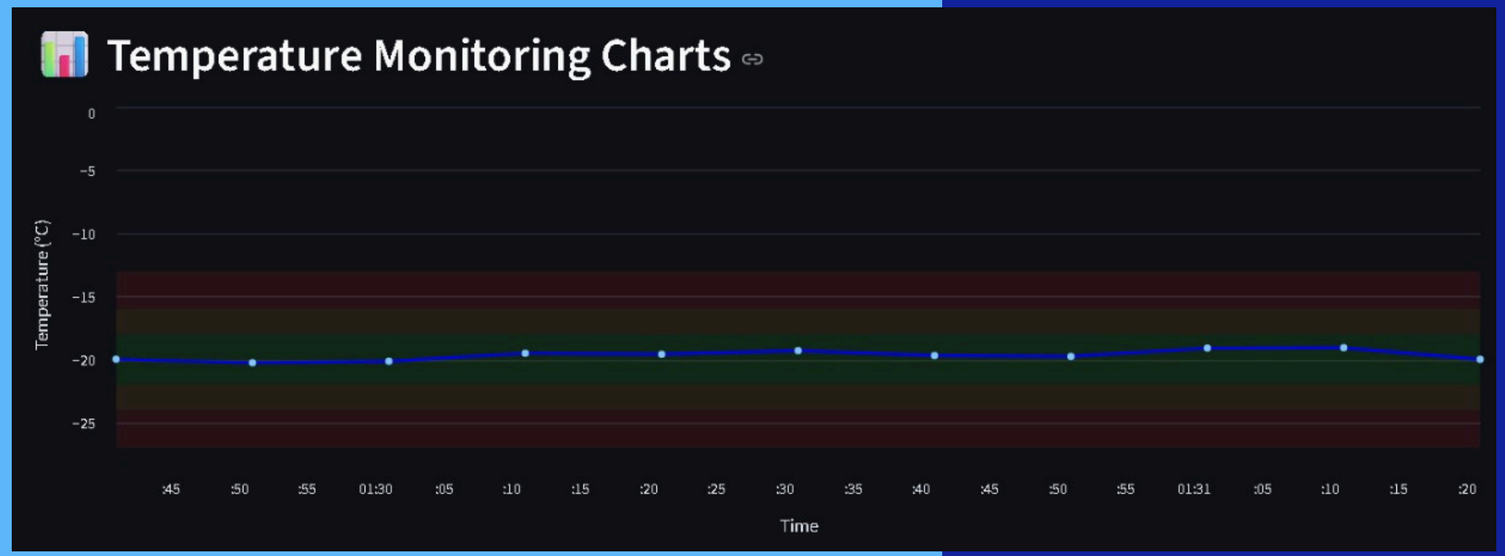
- Measuring system responsiveness from violation detection to notification

Compliance Scoring:

- Calculated based on percentage of time temperature and humidity remain within optimal

Data Quality Monitoring:

- Ensuring sensor readings maintain high reliability with minimal drift



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Project Outcome and Impact

Transforming warehouse cold storage operations

Enhanced Product Safety
Continuous monitoring ensures optimal storage conditions

Automated Monitoring:
Reduces manual errors and provides 24/7 coverage without human intervention

Data-Driven Insights:
Improves operational efficiency through trend analysis and performance metrics

Early Alert System: Prevents product spoilage by detecting temperature deviations before they become critical

Regulatory Compliance:
Maintains documentation and ensures adherence to storage requirements

Scalability: System architecture supports expansion to additional zones and integration with other warehouse systems

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Future Enhancements & Roadmap

Expanding capabilities and improving performance

Real IoT Sensor Integration:

Phase 1

Replace simulated data with actual temperature and humidity sensors with wireless connectivity

Advanced Predictive Analytics:

Phase 2

Implement machine learning models for anomaly detection and predictive maintenance

Expanded Alert Channels:

Phase 3

Add SMS, email, and voice notification options with customizable escalation policies

Mobile Application:

Phase 4

Develop dedicated mobile apps for iOS and Android with push notifications

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Thank you