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# A Survey On Cold Chain Monitoring Of Food And Vaccines Transport Using Iot

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***Abstract:*** Cold chain management plays a crucial role in maintaining the quality and safety of temperature-sensitive products such as vaccines and perishable food items. Improper temperature control during storage and transportation can lead to vaccine degradation and food spoilage, resulting in serious health and economic consequences. This survey focuses on IoT-based cold chain monitoring systems that use sensors, microcontrollers, and communication technologies to ensure continuous temperature and location tracking. Existing solutions using DHT22 temperature and humidity sensors, u-blox NEO-M8N GPS module, Wi-Fi communication, and cloud platforms are studied and analyzed. The survey highlights system capabilities, limitations, and implementation challenges. The paper aims to provide a clear understanding of current cold chain monitoring approaches and supports the development of an efficient, low-cost, and reliable IoT-based monitoring system.

***Index Terms*** **-** Cold Chain Monitoring, IoT, Vaccine Transportation, Food Logistics, Temperature Sensors, GPS Module, Cloud Monitoring

## I. Introduction

Cold chain monitoring refers to the continuous supervision of temperature conditions during the storage and transportation of sensitive products such as vaccines and food. Vaccines must be maintained within a narrow temperature range to preserve their effectiveness, while food products require controlled environments to prevent spoilage. Traditional cold chain methods rely on manual temperature checks and record keeping, which are prone to human error and delayed response.

With advancements in Internet of Things (IoT) technology, automated cold chain monitoring systems have become more reliable and efficient. These systems integrate DHT22 temperature and humidity sensors, ESP32 DevKit V2 microcontroller, Wi-Fi communication, and u-blox NEO-M8N GPS module to provide real-time environmental and location tracking. An OLED display is used for local data visualization. This survey explores existing IoT-based cold chain monitoring systems and evaluates their effectiveness for vaccine and food transport applications.

## II. Objective

- Monitor temperature and humidity continuously during transport and storage.
- Reduce manual temperature recording.
- Provide real-time alerts for temperature violations.
- Enable remote monitoring using cloud platforms.
- Track vehicle location using GPS module.
- Improve safety of vaccines and food products.
- Control cooling using DC fans based on temperature conditions.

## III. Feature Comparison

| Feature | Traditional Systems | Proposed IoT System |
|---|---|---|
| Monitoring | Manual | Automatic |
| Alerts | Delayed | Real-time |
| Data Storage | Paper-based | Cloud-based |
| Accuracy | Low | High |
| Scalability | Limited | High |

## IV. Scope

The scope of this system includes:

- Real-time temperature monitoring.
- Cloud data storage.
- GPS-based location tracking using u-blox NEO-M8N module.
- Real-time alert notifications via internet-based services.
- Future upgrades such as mobile app integration, predictive analytics, and AI-based temperature forecasting.

## V. Literature Review

Several commercial cold chain monitoring systems are available that use temperature loggers and IoT sensors. While these systems provide basic monitoring features, they are often expensive and lack customization for academic or small-scale use. Recent systems integrate GPS tracking modules for vehicle tracking and route monitoring.

**Problems with Existing Systems:**

- High implementation cost.
- Limited real-time monitoring in remote areas.
- Lack of full supply chain integration.
- High power consumption.
- Dependency on continuous internet connectivity.
- Limited customization.

## VI. System Architecture

The IoT-based cold chain monitoring system consists of temperature and humidity sensors connected to a microcontroller such as ESP32 DevKit V2. The sensor data is transmitted using Wi-Fi to a cloud server. A u-blox NEO-M8N GPS module provides real-time location tracking of transport vehicles.

The dashboard displays real-time and historical temperature data along with vehicle location. Alert mechanisms notify users when temperature exceeds safe limits. The system is designed to operate reliably in transport vehicles and storage unit.

## VII. BLOCK DIAGRAM

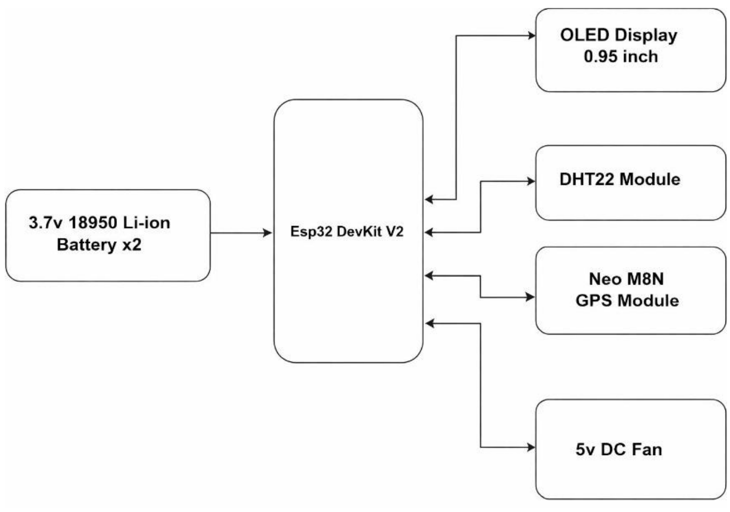


Fig. 1: Block diagram of IoT-based cold chain monitoring system

The block diagram represents an IoT-based environmental monitoring system using the ESP32 DevKit V2 as the main controller. The system is powered by two 3.7V 18650 Li-ion batteries that supply regulated power to all modules. A DHT22 sensor measures real-time temperature and humidity, while a NEO-M8N GPS module provides location tracking data such as latitude and longitude. A 0.95-inch OLED display is connected to show live sensor readings and GPS information locally. Additionally, a 5V DC fan is integrated for cooling control based on temperature conditions. The ESP32 processes all collected data and uses its built-in Wi-Fi capability to transmit information wirelessly for remote monitoring and analysis.

## VIII. SYSTEM TOOLS AND TECHNOLOGIES

### A. Hardware Components

- ESP32 DevKit V2
- u-blox NEO-M8N GPS Module
- OLED Display
- DHT22 Sensor
- DC Fans
- Li-ion Batteries

### B. Software Tools

- React.js, Vite.js, TypeScript
- Firebase
- OpenStreetMap API
- Arduino IDE
- Vercel

### C. Libraries Used

- WiFi.h
- HTTPClient.h
- TinyGPSPlus.h
- DHT.h
- U8g2.h

## IX. Applications

- **Vaccine Transportation Monitoring**

Ensures vaccines are maintained within safe temperature limits during transit.

- **Food Cold Storage Management**

Monitors temperature and humidity in cold storage facilities to prevent food spoilage.

- **Pharmaceutical Supply Chain Tracking**

Maintains quality of temperature-sensitive medicines throughout distribution.

- **Refrigerated Vehicle Monitoring**

Tracks environmental conditions and location of refrigerated transport vehicles in real time.

- **Warehouse and Distribution Center Monitoring**

Provides continuous monitoring of storage conditions to meet safety and regulatory standards.

## X. Conclusion

This survey demonstrates that IoT-based cold chain monitoring systems provide an effective solution for maintaining temperature compliance in vaccine and food transportation. By using affordable sensors, microcontrollers, and communication technologies, real-time monitoring and alert generation can be achieved efficiently. Compared to traditional methods, IoT solutions reduce human error and improve supply chain reliability. With future enhancements such as predictive analytics and mobile integration, the system can further strengthen cold chain safety and efficiency.

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