Real-time Monitoring and Controlling of Cold Storage Truck using IoT.

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ABSTRACT

Abstract— Refrigerator transportation is an essential component of the cold chain. The goal is to monitor the temperature and humidity inside the refrigerator trucks as well as manage the internal information of the refrigerator trucks. In this system, there is a design of an intelligent monitoring system based on the Internet of things, which realized monitoring temperature and humidity inside refrigerator trucks, as well as tracking the location of refrigerator trucks in real-time throughout the transportation process by using advanced technologies such as MQTT, Cloud Computing, sensor technology, and wireless communication technology. The proposed system included an ESP8266 as the main control unit, as well as a BME280, a Magnetic door Sensor, an RTC, and a GPS module. The system is extremely powerful in terms of monitoring refrigerated trucks from anywhere and at any time via a mobile application. This system will be able to control and monitor itself using a mobile and web application. With MQTT, we will achieve good results in data monitoring such as temperature, humidity, and door status. It is pleased with the performance of the designed refrigerated truck monitoring system as determined by monitoring system analysis and experiment results. Furthermore, the main advantages of this proposed system are that it reduces the human effort for manual monitoring and loss due to an uncontrolled environment.

Keywords— Refrigerator Trucks, Internet of Things, MQTT, Intelligent Monitoring.

1. INTRODUCTION

In recent years, the Internet of Things (IoT) has revolutionized various industries, and one area where it has made a significant impact is cold storage and transportation. The efficient monitoring and management of temperature-sensitive goods, such as food and pharmaceuticals, during transportation is crucial to ensuring their quality and safety. In this context, an IoT-based cold storage truck monitoring system utilizing the ESP8266 microcontroller, temperature, humidity, water leakage sensor, door sensor, and Firebase platform has emerged as a reliable solution.

The ESP8266 microcontroller serves as the central control unit in this system, enabling connectivity to the internet and facilitating communication with the various sensors installed in the cold storage truck. The temperature and humidity sensors continuously monitor the environmental conditions inside the truck, ensuring that the desired temperature and humidity levels are maintained throughout the journey. Additionally, the water leakage sensor detects any potential leaks or spills, alerting the relevant personnel to take immediate action to prevent damage to the goods.

The implementation of an IoT-based cold storage truck monitoring system offers immense potential and benefits. By leveraging these technologies, real-time monitoring, and control of crucial parameters such as temperature, humidity, water leakage, and door status become achievable, ensuring the preservation and safety of perishable goods during transportation. This comprehensive solution enhances efficiency, minimizes losses, and enables proactive maintenance, as data collected from the sensors can be securely stored and analyzed in Firebase, facilitating intelligent decision-making and timely interventions. Ultimately, this integration of IoT and cloud technologies empowers businesses to optimize their cold storage logistics, streamline operations, and deliver superior quality products to customers while driving growth and profitability. Cold chain operations are vulnerable

to traffic delays, human error, mechanical faults, and a variety of other issues. Many products nowadays are temperature sensitive, and shipping temperature-sensitive items such as food, vaccines, chemicals, pharmaceutical products, and so on poses a risk. As a result, we need to monitor these products using IOT technology to avoid food and medicine from spoiling, increasing concerns about the safety of the products we consume. As a result, we must focus on real-time cold chain monitoring using IoT technologies. As a result, logistic companies who deliver temperature-sensitive goods must verify the temperature before delivering the items.

2. LITERATURE SURVEY

The agrifood chain is facing significant new challenges nowadays. Among others, monitoring and controlling temperature along supply chains emerges as a key aspect to deal with food waste [1-3], as well as increasing both food safety and the quality offered to consumers. Whereas the early stages of processing and distribution compliance with the temperatures established for food safety was reached, however, in the last three stages (considering here transport, retail, and households), temperature control and maintenance have become particularly complex. In the retail sector in particular, the scarcity of data available on the fulfilment of cold chain control is highlighted. In addition, there are many studies confirming that the temperature of display cabinets in refrigeration units is not always the appropriate one, according to safety standards.

In Europe, there is a regulation by the European Council and Parliament assigning food companies the responsibility for complying with temperature control requirements and microbiological criteria applicable to food products, as well as cold chain maintenance [4]. Concerning this last aspect, the regulation establishes the importance of controlling temperatures and proper operation of refrigeration equipment, considering that daily temperature reading is a valid method to control the cold chain in retail establishments. However, there are studies proving that this method cannot guarantee compliance with the perishable food safety specifications, especially in southern Spain.

Among the technologies offering temperature control solutions currently available throughout the cold chain, wireless sensor surveillance technologies, especially radio frequency (RF) and wireless sensor networks (WSN), have been regarded as leaders in this field [4], with many works on its implementation to achieve global food temperature traceability at different points in the chain, becoming part of broader food safety systems. Nevertheless, far fewer research studies in the retail sector refer to cabinet and refrigeration equipment temperature control. Most of the scientific literature focusing on the retail sector emphasizes the estimation of the shelf life of food located in refrigeration equipment or whether they keep the required temperature levels [5-7] yet avoiding a deeper study of the systems used for temperature measurement and monitoring.

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On a commercial level, there are large companies specialized in refrigeration equipment [10], which offer systems for monitoring temperature, but which have the disadvantage of being expensive and do not offer the possibility of easily accessing the data generated or being integrated into systems that monitor other types of parameters. Other options, based on data recording devices located in each refrigeration unit, offer a cheaper alternative, but without constituting an affordable solution for small and medium-sized companies, for which this term is critical. This is the line in which the proposal presented in this work is situated to respond to the challenge of monitoring the temperature of refrigeration equipment in the retail sector, by using new trends in technological development, such as free and open-source hardware (FOSH). FOSH is a hardware whose design is made publicly available so that anyone can study, modify, distribute, make, and sell the design or hardware based on that design.

3. SYSTEM ARCHITECTURE AND METHODOLOGY

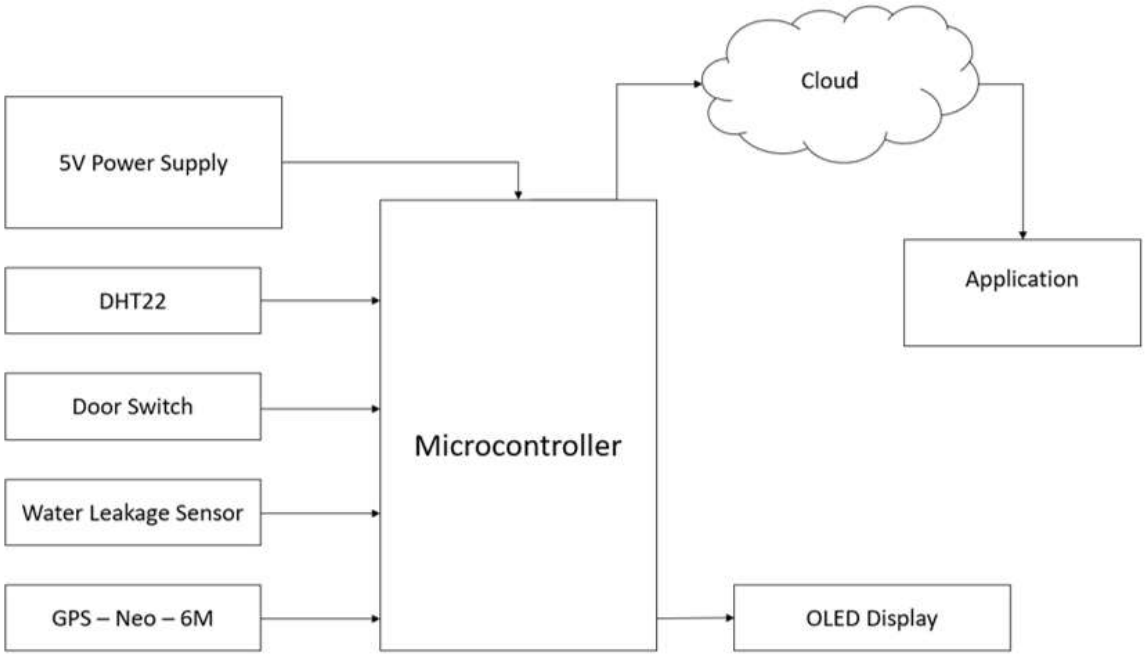

Fig -1: System Architecture

The system composition diagram was as shown in Figure 1. The temperature and humidity acquisition module constituted by a high-performance temperature and humidity sensor can be used to read the temperature and humidity conditions data within the refrigerator trucks in real-time. IoT-based cold storage truck monitoring using the ESP8266 is a system that enables real-time monitoring and control of temperature, humidity, water leakage, and door status in cold storage trucks.

The ESP8266, a popular Wi-Fi module, acts as the central hub for collecting sensor data and transmitting it to the cloud for analysis and storage. This setup allows truck operators to ensure the optimal condition of perishable goods during transportation. To measure temperature and humidity more accurately, more temperature and humidity acquisition modules can be placed in the box according to actual needs. The door switch is used to monitor the monitoring device switch state in the process of goods transportation to avoid goods loss. And the refrigerator tracks position is located and tracked by the GPS satellite and returns its positioning information with temperature and humidity data, door switch state, and cargo information to the monitoring center through the network Intelligent Monitoring System on Refrigerator Trucks Based on the Internet of Things.

Using intelligent analysis software on the remote monitoring center terminal to display refrigerator trucks' temperature and humidity data, door switch state, and cargo information in real-time to locate and track the location of refrigerator trucks to implement intelligent monitoring management and make the whole system constitute a real-time, intelligent thing networking. Additionally, water leakage and door sensors are integrated into the system to enhance security and prevent potential damage. The water leakage sensor detects any water leaks within the truck and immediately sends an alert to the ESP8266. Similarly, the door sensor monitors the opening and closing of the truck doors. If any unauthorized access or abnormal door activity is detected, an alert is triggered. These alerts are also sent to the Firebase platform, allowing operators to take timely action to rectify the situation and maintain the integrity of the cargo.

4. CONCLUSIONS

The refrigerator trucks intelligent monitoring system which put forward by this proposed system is based on content networking technology. And combined with cloud, sensor technology and wireless communication technology, etc. to realize purposes such as monitoring the transport process intelligently, improving the refrigerator trucks' transport efficiency, preventing the deterioration of goods in transit, and avoiding the loss of goods during transportation, and so on.

The proposed system is very powerful to monitor refrigerated trucks from anywhere and anytime using mobile applications. This system will be capable of doing control and monitoring through mobile and web applications. We will achieve the good result to data monitoring such as Temperature, humidity, and door status with MQTT. It is satisfied with the performance through the analysis of monitoring system and experiment results for the designed refrigerated truck monitoring system. Moreover, this proposed system has main advantages which are minimize the human effort for the manual monitoring and loss due to uncontrolled environment.

Though we can achieve all the goals of our project but still we think that lots of advancement can be made on this project. We have provided the platform and the platform is ready for everyone to work on it. For advancements, we need more time, money, and hard work. Money would remain the critical issue cause to upgrade the project many of the staff would need an upgradation.

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