e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:06/Issue:04/April-2024 Impact Factor- 7.868 www.irjmets.com

SHIPPING CONTAINER WITH IOT: A SMART WAY TO MONITOR ENVIRONMENT AND LOCATION

Thallapally Anusha[*1], Puppala Jayasurya[*2], Gogula Shylaja[*3], Preethika Buggaveeti[*4], Munigala Subhash[*5]

[*1]Assistant Professor, Dept. Of Computer Science & Engineering (Networks), Kakatiya Institute Of Technology And Science, Warangal, India.

[*2,3,4,5]Dept. Of Computer Science & Engineering (Networks), Kakatiya Institute Of Technology And Science, Warangal, India.

DOI : https://www.doi.org/10.56726/IRJMETS52672

ABSTRACT

This paper introduces a Smart shipping container system with IoT focuses on the innovative approach to monitor environmental conditions and track location within the logistics and shipping industry. The integration of Internet of Things (IoT) technology into shipping containers provides a smart solution for real-time data collection and analysis. The system employs sensors to monitor key parameters such as temperature, humidity, vibration, smoke, light, and also GPS location. This comprehensive approach ensures the safety and integrity of diverse cargo types during transportation. Leveraging technologies like MQTT protocol and cloud computing through platforms such Google Firebase enhances the system's efficiency and flexibility. The proposed solution addresses limitations observed in existing projects by offering a scalable, adaptable, and cost-effective approach to smart container technology, catering to the dynamic needs of the logistics industry.

Keywords: IoT, Mobile application, Real-time data, Firebase Cloud, Environment monitoring sensors.

I. INTRODUCTION

In the ever-evolving landscape of the shipping industry, the integration of Internet of Things (IoT) technology has emerged as a transformative solution for enhancing, monitoring and management of shipping containers. This paper explores a smart and innovative approach that utilizes the ESP8266 microcontroller board, along with a suite of sensors including vibration, temperature, humidity, smoke, and a GPS module. This integrated system aims to provide real-time insights into the environment and location of shipping containers, offering stakeholders an unprecedented level of control and awareness throughout the transportation process The ESP8266, acting as a central hub, orchestrates seamless communication between the various sensors within the container. The inclusion of a vibration sensor enables the detection of potential mishandling during transit, ensuring the safety of delicate cargo. Temperature and Humidity sensors address the critical need for monitoring environmental conditions, particularly for goods sensitive to variations in climate. The smoke sensor introduces an additional layer of security, detecting potential fire hazards within the container. Finally, the GPS module provides precise geo location data, contributing to optimized logistics and route planning.

Crucially, the collected sensor data is securely transmitted and stored in the cloud. Leveraging cloud computing technologies, such as Firebase cloud, facilitates centralized data storage, enabling stakeholders to access real-time information about the container's environment and location. Furthermore, the system is designed to send instant alerts to stakeholders through an Android mobile application. These alerts serve as proactive notifications, empowering stakeholders to make informed decisions and take prompt actions in response to any anomalies or deviations from predefined parameters.

The advent of Internet of Things (IoT) technology has revolutionized the way we approach logistics and transportation, and in particular, the monitoring of shipping containers. This paper introduces an innovative and intelligent solution that combines the capabilities of the ESP8266 microcontroller with a suite of advanced sensors, including vibration, temperature, humidity, smoke, and a GPS module. The amalgamation of these technologies forms a smart container system that not only monitors the container's environment in real-time but also precisely tracks its location throughout its journey.

In summary, the system can integrate with blockchain technology in future to enhance transparency and security in supply chain transactions. By recording sensor data and container events on an immutable and

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:06/Issue:04/April-2024 Impact Factor- 7.868 www.irjmets.com

decentralized ledger, the system ensures a tamper-proof and auditable record of the container's journey, providing stakeholders with a higher level of communication, trust and accountability.

II. METHODOLOGY

Building a Smart shipping container system involves a multi-step process that integrates hardware components, sensor data collection, cloud services, mobile application development.

Collecting Sensor Data

To begin with, the data collection phase requires setting up the hardware components. This involves connecting the DHT11 (Temperature), MQ2 (Smoke), LM393 (LDR Light), SW-420 (Vibration) sensors and GPS module to an ESP8266 microcontroller. The sensors, responsible for measuring environment such as temperature, humidity, light intensity, vibration, smoke and location tracking should be interfaced with the microcontroller using appropriate communication protocols such as MQTT (Message Queuing Telemetry Transport). The firmware for the ESP8266 needs to be developed to read data from these sensors, employing sensor libraries and datasheets to interpret raw data accurately.

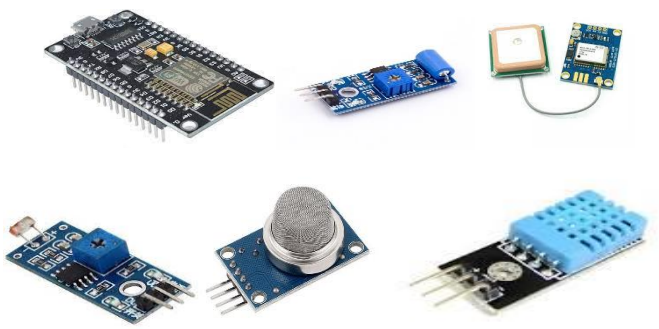

Figure 1: Components of Smart shipping container.

The vibration sensor measures shocks or disturbances, providing insights into potential mishandling of the container. Temperature and humidity sensors continuously monitor the container's internal environment, ensuring compliance with specific conditions for sensitive goods. The smoke sensor detects potential fire hazards, registering the concentration of smoke particles. Simultaneously, the GPS module tracks the container's real-time location. This diverse set of data is securely transmitted to the cloud.

The MQTT protocol facilitates lightweight and efficient communication between the ESP8266 and the cloud, ensuring real-time data transfer. The system is designed to generate alerts based on sensor readings, and these alerts are communicated to stakeholders through an Android mobile application. This integrated approach to collecting sensor data not only enhances cargo safety but also provides stakeholders with comprehensive insights into the container's environment and location.

Transmitting Data to Firebase Cloud

Integrating Firebase Cloud into the smart shipping container system involves configuring a Firebase project, setting up authentication if necessary, and designing a database structure to accommodate sensor data. The ESP8266, functioning as the central processing unit, is then adapted to include Firebase libraries, allowing it to establish a secure connection and transmit collected sensor information to the cloud. The real-time capabilities of Firebase are leveraged to enable instantaneous updates and notifications as sensor data is received. This integration ensures a seamless and secure flow of sensor information to Firebase Cloud, facilitating efficient monitoring and analysis of the container's environment and location.

Mobile Application Development

The development of the Android mobile application for the smart shipping container system involves a meticulous process aimed at providing stakeholders with a user-friendly interface for real-time monitoring and interaction. The application's design focuses on intuitiveness, allowing users to seamlessly access and interpret essential sensor data, including temperature, humidity, light, vibration, and location. Integrating Firebase into the app establishes a secure connection with the cloud, facilitating the retrieval of real-time updates and enabling notifications through Firebase Cloud Messaging. The user interface emphasizes the display of real-

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:06/Issue:04/April-2024 Impact Factor- 7.868 www.irjmets.com

time sensor data, while features for configuring alerts, accessing historical information, and customizing settings enhance the application's functionality. The inclusion of map integration enriches the user experience by visually representing the container's journey. Testing and debugging are crucial to guarantee the app's reliability, responsiveness, and a seamless user experience. This mobile application plays a pivotal role in ensuring transparency, efficiency, and timely decision-making in the context of smart shipping container management.

III. MODELING AND ANALYSIS

To create a smart shipping container system, start by figuring out what it needs to do, like tracking location or monitoring temperature. Choosing the right hardware, like sensors, and write code to make them work together. Build a mobile app so users can interact with the system. Use Firebase to handle things like storing data in the cloud. Analyze the data collected from sensors to find useful information. Ensuring everything is secure and testing it well before putting it into use.

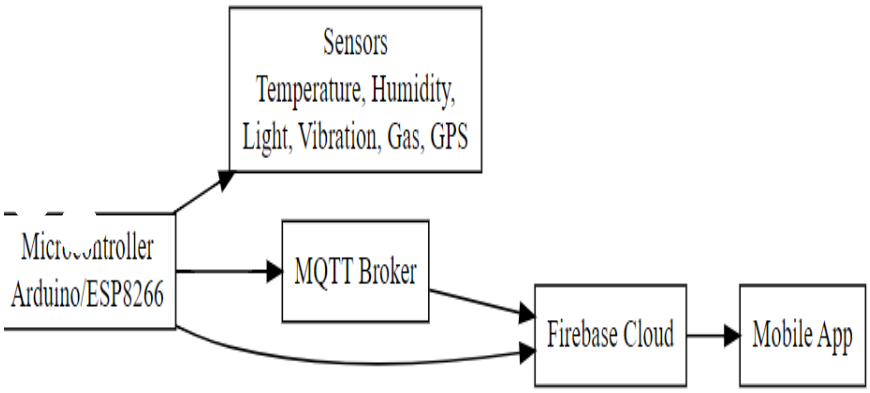

Figure 2: Block Diagram of Smart Shipping Container.

IV. RESULTS AND DISCUSSION

The intelligent system that monitors of the smart shipping container system has yielded significant results, revolutionizing the landscape of container management in the logistics and shipping industry. Real-time monitoring, facilitated by an array of integrated sensors, provides stakeholders with immediate access to crucial data such as temperature, humidity, vibrations, and location. This real-time visibility empowers proactive decision-making, preventing potential issues and ensuring the safety of transported goods. The system's incorporation of preventive measures, based on sensor data, has led to a notable reduction in downtime and maintenance costs, as potential issues are identified and addressed before they escalate. Compliance with environmental regulations is enhanced through precise control of temperature and humidity conditions, maintaining the integrity of cargo sensitive to environmental factors. The integration of a GPS module enables optimized logistics and route planning, improving overall supply chain efficiency and bolstering shipment security. The Android mobile application, providing a user-friendly interface, ensures seamless interaction with the system, delivering timely alerts and notifications to stakeholders.

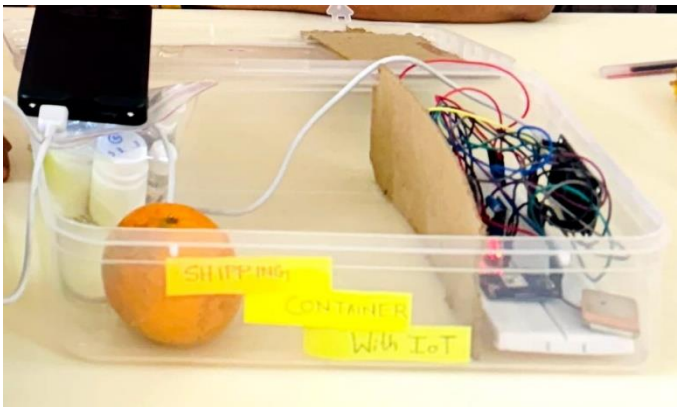

Figure 3: Smart Shipping container.

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:06/Issue:04/April-2024 Impact Factor- 7.868 www.irjmets.com

With data analysis and trend identification capabilities, the system not only addresses immediate concerns but also contributes to continuous improvement by identifying areas for optimization. The scalability and adaptability of the system, driven by cloud computing and the MQTT protocol, position it as a versatile solution capable of meeting the dynamic needs of the logistics industry. In essence, the smart shipping container system has proven to be a transformative and technologically advanced tool, optimizing operations, enhancing cargo safety, and fostering a new era of efficiency in container management.

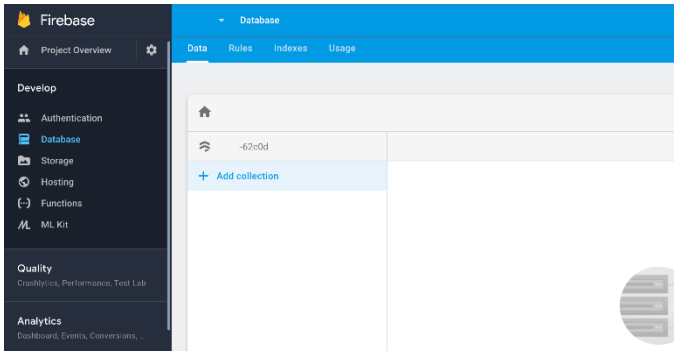

Figure 4: Firebase Cloud.

A mobile app is developed to enable effective user interaction. This app connects to the cloud platform to retrieve real-time sensor data securely. Users can get alerts and receive updates in real-time, fostering a seamless and interactive experience.

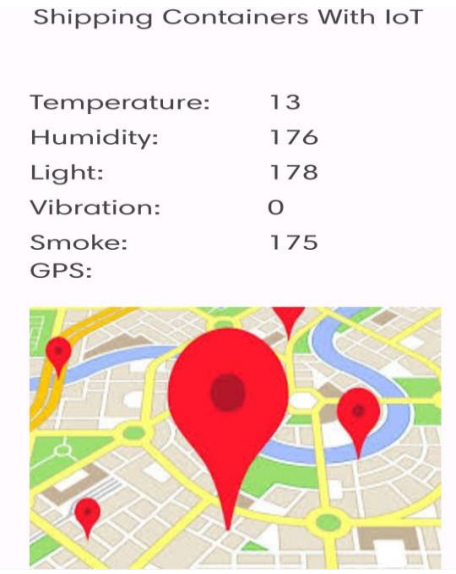

Figure 5: Mobile Application.

The integration of a diverse set of sensors, including temperature, humidity, vibration, smoke, and GPS, forms the backbone of real-time environmental and location monitoring. This sensor suite not only ensures the safety and integrity of transported goods but also enables a proactive response to potential risks during transit. The central processing unit, embodied by the ESP8266, orchestrates the seamless communication and data transmission between sensors and the cloud-based storage system, specifically Firebase, leveraging its real-time capabilities. The use of the MQTT protocol further optimizes communication efficiency, ensuring that even resource-constrained devices contribute to the overall system robustness. The Android mobile application serves as a user-friendly interface, providing stakeholders with instant access to critical information and alerts.

V. CONCLUSION

In conclusion, the implementation of the smart shipping container system represents a pioneering venture into the realm of modern logistics, harnessing advanced technologies to redefine container management. The integration of a comprehensive sensor suite, including temperature, humidity, light, vibration, smoke, and GPS, has laid the foundation for real-time monitoring and proactive risk mitigation. The ESP8266, acting as the

central processing unit, orchestrates seamless communication between sensors and the cloud-based Firebase storage system. Leveraging the MQTT protocol ensures efficient data transmission, even for resource-constrained devices, contributing to the overall robustness of the system. The Android mobile application serves as an intuitive interface, granting stakeholders immediate access to critical information and real-time alerts. Its holistic approach, encompassing preventive maintenance, real-time alerts, and comprehensive analytics, ensuring cargo safety, operational efficiency, and adaptability to varying logistics scenarios. Ultimately, the smart shipping container system emerges as a transformative solution, optimizing container management through a synthesis of sensor technology, cloud computing, and user-friendly mobile interfaces, paving the way for a new era in intelligent logistics.

VI. REFERENCES

[1] K. Salah et al., "IoT-Enabled Shipping Container with Environmental Monitoring and Location Tracking," 2020 IEEE 17th Annual Consumer Communications & Networking Conference (CCNC), Las Vegas, NV, USA, 2020, pp. 1-6, doi: 10.1109/CCNC46108.2020.9045495.

[2] R. J. Craddock and E. V. Stansfield, “Sensor Fusion for Smart Containers”, IEE Signal Processing Solutions for Homeland Security, London, UK, pp. 12-pp, 2005.

[3] M. Poverello, ‘CMA CGM – to introduce ‘smart' containers to its box fleet', 2015, [online]. Available: https://mpoverello.com. [Accessed: 13-March-2019].

[4] P. E. Shapes, Blue Clover Design LLC, (2009), Smart shipping and storage container, 7592916, U.S. Patent, USA.