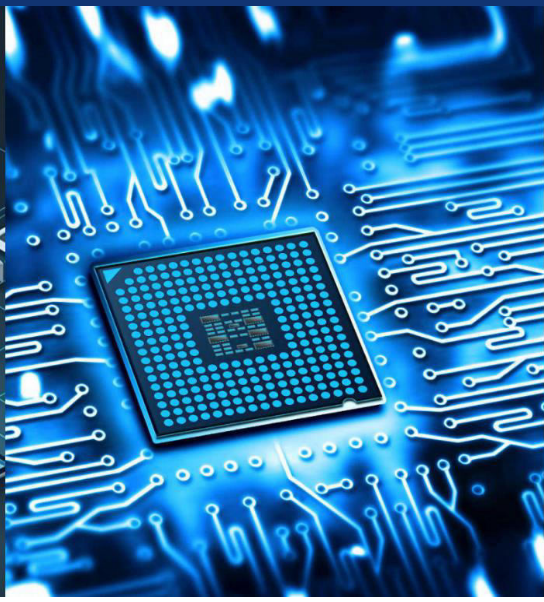
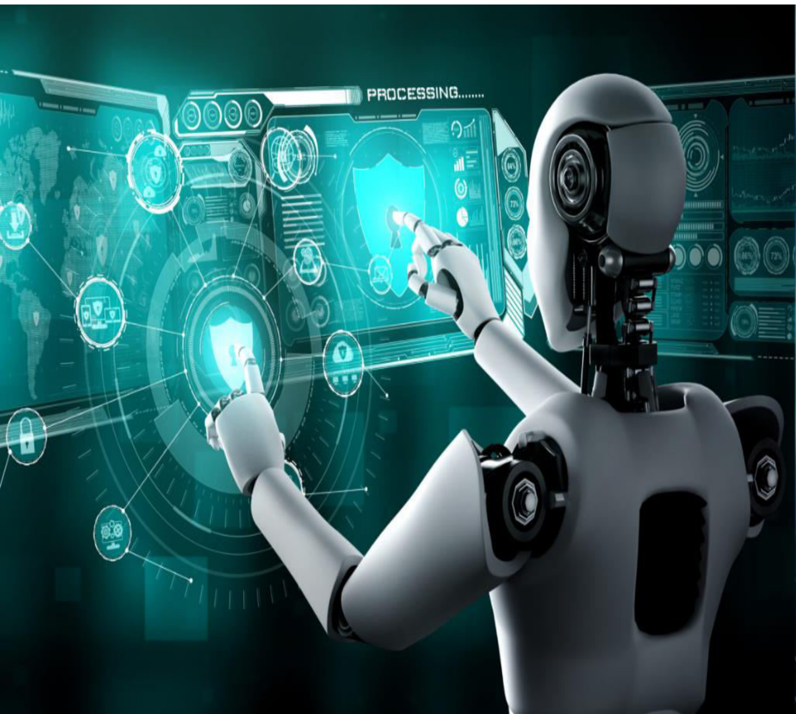
ISSN(O): 2320-9801
ISSN(P): 2320-9798


International Journal of Innovative Research in Computer and Communication Engineering

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)



Impact Factor: 8.771 **Volume 13, Issue 5, May 2025**

www.ijircce.com | e-ISSN: 2320-9801, p-ISSN: 2320-9798| Impact Factor: 8.771| ESTD Year: 2013|

International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

Battery Management System for Electric Garbage Compactor Trucks

Adarsh R A[1], Dr S Bhargavi[2]

Student, Electronics and communication, SJC Institute of Technology, Chickaballapur, India[1]

Professor, Electronics and communication, SJC Institute of Technology Chickaballapur, India[2]

ABSTRACT: A real-time Battery Management System (BMS) designed to optimize battery performance, safety, and longevity in electric garbage compactor trucks. Traditional diesel-powered garbage trucks contribute significantly to air pollution, noise pollution, and excessive fuel consumption, particularly during garbage compression, where engines are kept idling or running at high speeds. To address these issues, electrification of garbage compactor systems has gained attention as an eco-friendly alternative. However, effective battery management remains a key challenge in ensuring efficient power utilization and long-term battery health.

KEYWORDS: significantly, ensuring, longevity.

I. INTRODUCTION

This study proposes a low-cost, microcontroller-based BMS using NUVOTON's Cortex- M4 chip, specifically designed to monitor, protect, and optimize battery performance in electric garbage trucks. The system consists of two main components: a Battery Monitoring Circuit (BMC) and a Battery Control Unit (BCU). The BMC is responsible for tracking voltage, temperature, and charge levels of individual battery cells, while the BCU performs real-time calculations, energy balancing, and fault detection. To improve battery State of Charge (SoC) estimation, the study introduces a hybrid approach that integrates the Coulomb Counting Method (CCM) and Open Circuit Voltage (OCV) method. This combination helps reduce cumulative errors often associated with Coulomb Counting while ensuring accurate battery tracking over extended usage periods.

Experimental validation was conducted by implementing the BMS in a real-world electric garbage compactor truck. The system was tested under various operational conditions, including charging, discharging, and compaction cycles, to evaluate its effectiveness. Results showed that the proposed real-time SoC estimation method significantly improved accuracy, reduced estimation errors, and enhanced overall battery utilization. Compared to conventional methods, the hybrid approach provided more reliable tracking of battery health and charge levels, minimizing risks associated with overcharging or deep discharging.

Beyond garbage trucks, the proposed BMS architecture has potential applications in electric vehicles (EVs), industrial energy storage, and renewable energy systems. The system was tested under various operational conditions, including charging, discharging, and compaction cycles, to evaluate its effectiveness. By ensuring cost-effective, real-time battery monitoring, this research contributes to the advancement of sustainable transportation and energy-efficient technologies, supporting global efforts toward carbon reduction and greener urban infrastructure.

The electrification of garbage compactor trucks is a key step toward reducing fuel consumption, noise pollution, and carbon emissions. Traditional diesel-powered trucks require continuous engine idling during garbage collection and compression, leading to environmental and operational inefficiencies. Electric garbage compactor trucks address these challenges by utilizing battery-powered compression systems. However, battery degradation over time affects performance, making an efficient Battery Management System (BMS) crucial for monitoring and optimizing battery health. This study focuses on developing a real-time BMS using a NUVOTON Cortex-M4 microcontroller, integrating the Coulomb Counting Method (CCM) with the Open Circuit Voltage Method (OCVM) to enhance State of Charge (SoC) estimation accuracy. The proposed system aims to improve battery lifespan, prevent overcharging and over-discharging, and ensure safe operation. By implementing this BMS in electric garbage compactor trucks, the study contributes to advancing sustainable waste management and optimizing battery efficiency in electric vehicle applications.

www.ijircce.com | e-ISSN: 2320-9801, p-ISSN: 2320-9798| Impact Factor: 8.771| ESTD Year: 2013|

International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

II. LITERATURE SURVEY

The proposed when garbage trucks perform garbage collection and compression operations, it is common to keep the engine idling and even increase the engine speed during garbage compression, which can lead to noise, air pollution, increased fuel consumption, and carbon emissions. Adopting an electric compression system can effectively reduce these issues. The battery pack used in electric garbage trucks is the core energy source of the vehicle, making proper battery management system crucial for the overall safety and performance of the vehicle. This study aims to utilize NUVOTON's

Cortex-M4 chip to develop a battery management system specifically designed for electric garbage trucks.[1]The proposed system introduces the Municipal solid waste management remains a major problem in urban areas, leading to serious health and environmental issues. Consequently, trash bins are placed in many places to handle the municipal solid waste, but these bins can overflow, spreading around the area, polluting the environment, and causing in convenience to the pub lic. Therefore, there is a need for a real-time remote monitoring system that alerts the level of garbage in the trash bins to the municipality or a waste management company. To manage the municipal solid waste efficiently, this article presents the development and validation of a selfpowered, LoRa WAN Internet-of-Things (IoT)- enabled trash bin level monitoring system.[2]

The proposed the Waste management has always been a challenge to the development of urban cities. The existing waste management system in India involves human intervention at each stage. This causes serious health issues to sanitation workers. In sanitation workers in Delhi lost their life due to improper waste management practice.[3]

III. ARCHITECTURE OF THE SYSTEM

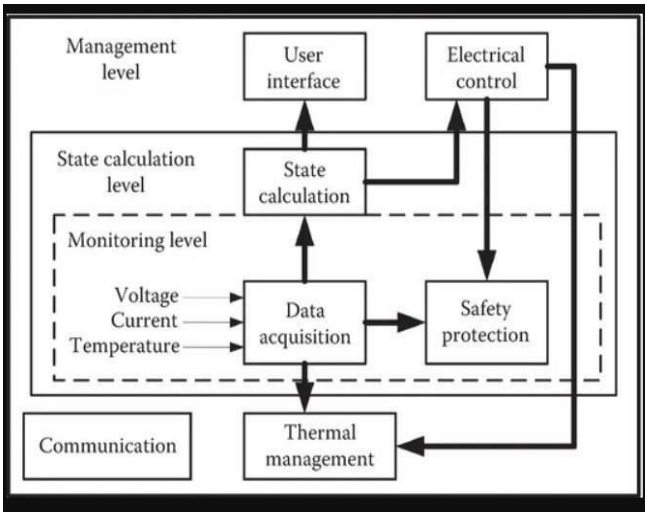


Fig 3.1: Block diagram for battery management system (BMS) for Electric Garbage Compactor Trucks

At the core of the system is the Battery Monitoring section, which tracks critical parameters such as current, voltage, and temperature. The Data Acquisition unit is responsible for collecting real-time information regarding these parameters, ensuring that any fluctuations or anomalies are promptly detected. This data is then processed by the Safety Protection unit, which implements protective measures to prevent hazardous conditions such as overcharging, over-discharging, and overheating. By doing so, the BMS ensures that the battery operates within safe limits, reducing the risk of failures or accidents.

The User Interface provides feedback to users, allowing them to monitor battery performance and receive alerts in case of malfunctions or safety concerns. Meanwhile, the Electrical Control system ensures that the battery is efficiently integrated into the overall power system, managing power distribution and optimizing energy flow to different connected devices or subsystems.

www.ijircce.com | e-ISSN: 2320-9801, p-ISSN: 2320-9798| Impact Factor: 8.771| ESTD Year: 2013|

International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

IV. FLOW ALGORITHM

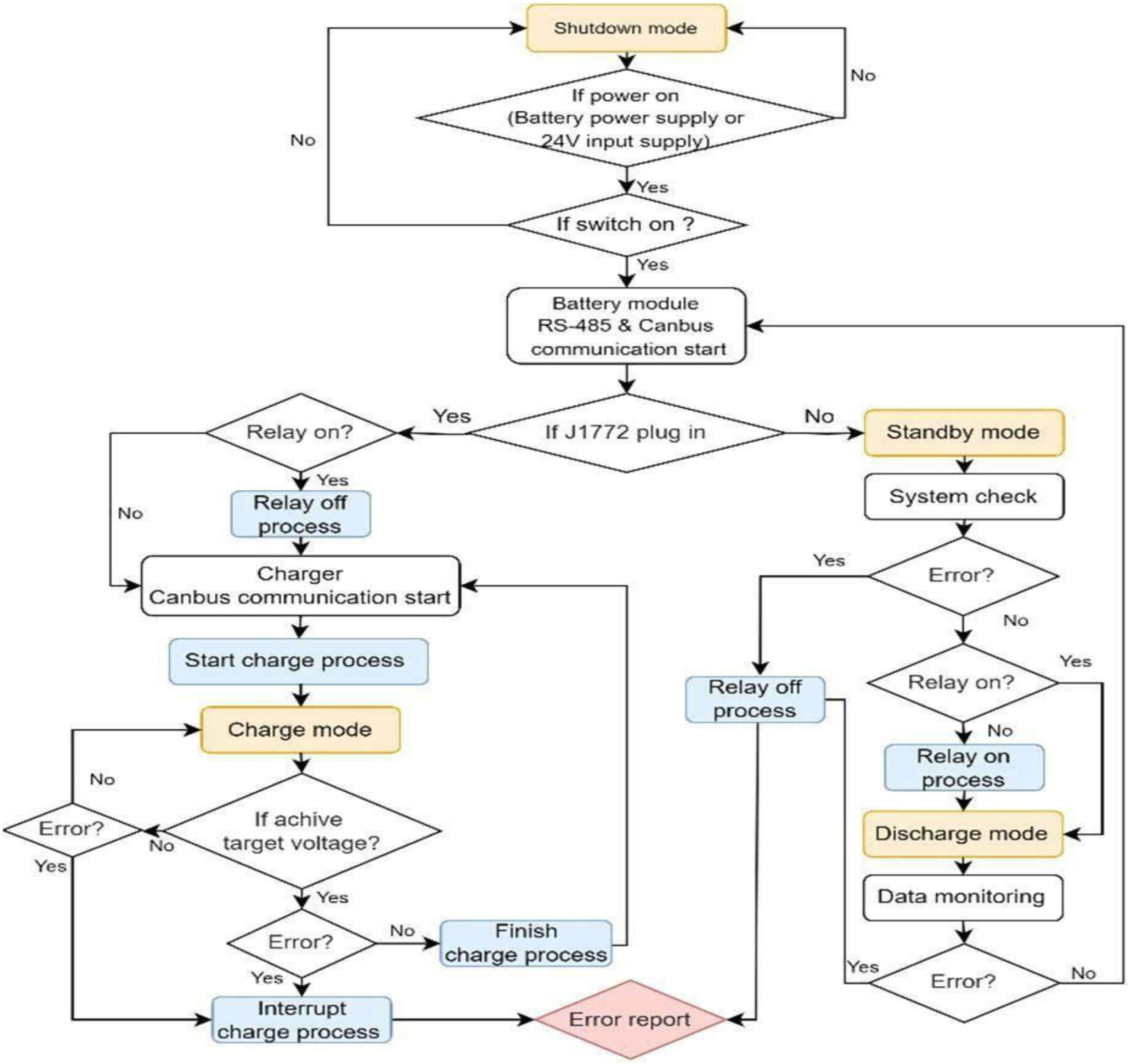


Figure 4.1: Flow diagram for battery management system (BMS) for Electric Garbage Compactor Trucks

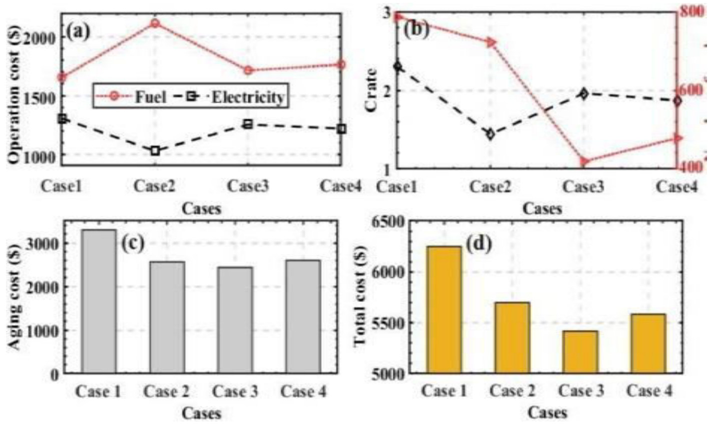
V. RESULTS AND NOVEL CONTRIBUTION

The results of this study demonstrate the effectiveness of the proposed Battery Management System (BMS) for electric garbage compactor trucks. Experimental testing involved cyclic charge-discharge evaluations on battery cells and modules, followed by real-world integration into an electric garbage truck. The results indicate that the proposed real-time online estimation method significantly improves State of Charge (SoC) accuracy compared to the traditional Coulomb Counting Method (CCM). During testing, it was observed that cumulative errors in the conventional CCM led to inaccuracies in long-term SoC estimations, whereas the proposed method, which integrates Open Circuit Voltage (OCV) corrections, was able to dynamically adjust initial SoC values and minimize estimation errors. Additionally, real-world compression tests confirmed that the battery module voltages remained stable, and the system effectively recorded voltage, current, and SoC variations during the truck's operations.

www.ijircce.com | e-ISSN: 2320-9801, p-ISSN: 2320-9798| Impact Factor: 8.771| ESTD Year: 2013|

International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)



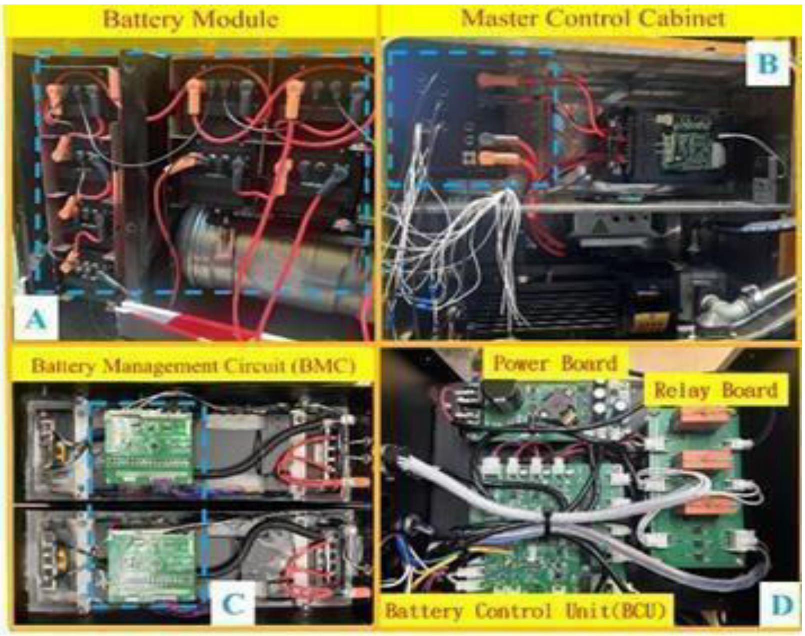


Fig5.1: Integration of the proposed BMS into an electric garbage compactor truck

After the battery cells and modules undergo different cycle tests using the charge and discharge equipment, the designed battery management system is integrated into the electric garbage compaction truck as shown in Figure 6.1. The components are arranged in sequence as follows: A. eight sets of battery modules, B. main control cabinet, C. BMC inside the battery modules, and D. various circuits inside the main control cabinet, including the BCU, power board, Relay board, and Relay components.Subsequently, the parameters used for the input into the proposed algorithm for the real-time online estimation of battery status (implemented by the BCU in the main control cabinet) to perform various integrated testing experiments.

VI. CONCLUSION

The effectiveness of the developed BMS was evaluated through a series of experimental and real-world tests. Initially, cyclic charge-discharge tests were conducted on individual battery cells to analyze their capacity degradation over multiple cycles. The results were used to create an Open Circuit Voltage (OCV) correction lookup table for improved State of Charge (SoC) estimation. After validating the accuracy of these parameters, the BMS was integrated into an electric garbage compactor truck for real-world testing.

www.ijircce.com | e-ISSN: 2320-9801, p-ISSN: 2320-9798| Impact Factor: 8.771| ESTD Year: 2013|

International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

VII. ACKNOWLEDGMENT

I am sincerely thankful to all my teachers for their guidance for my seminar. Without their help it was tough job for me to accomplish this task. I am especially very thankful to my guide Dr. S Bhargavi for his consistent guidance, encouragement and motivation throughout the period of this work. I also want to thank our Head of the Department (E&C) Dr.Rangaswamy for providing me all necessary facilities.

REFERENCES

[1] Tsung-Hsun Wu 1, Pei-Yin Chen 1, "Battery Management System for Electric Garbage Compactor Trucks," IEEE Access, vol. 11,pp. 15449 - 15459, 2024.

[2] S.R. Jino Ramson , Member, IEEE, Vishnu S. , A. Alfred Kirubaraj, Theodoros Anagnostopoulos, and Adnan M. Abu-Mahfouz, " A LoRa WAN IoT-Enabled Trash Bin Level Monitoring System ", IEEE Access, VOL. 18, NO. 2, FEBRUARY 2022.

[3] Gouri S Nair1, Devika P V1, Jyothi sree K1, Niveda Giriraj1, and Sai Shibu N B "Architecture, Concept and Algorithm for Data Analytics based Zero Touch Waste Management in Smart Cities," IEEE Xplore Part Number: CFP21V66-ART; ISBN: 978- 1-6654-2867-5 2022.

[4] Amareshwar Karatagi, ''Integrating Electric Vehicle (EV) in Waste Management for Garbage Collection using LoRa Technology,'' Proceedings of the Sixth International Conference on Intelligent Computing and Control Systems (ICICCS 2022) IEEE Xplore Part Number: CFP22K74-ART; ISBN: 978-1-6654-1035-9

[5]] Md Masuduzzama, "Lithium-ion battery pack robust state of charge estimation, cell inconsistency, and balancing," IEEE Access, vol. 9, pp. 50570– 50582, 2021.

[6] B. Yang, J. Wang, P. Cao, T. Zhu, H. Shu, J. Chen, J. Zhang, J. Zhu, "Classification, summarization and perspectives on state-of-charge estimation of lithium-ion batteries used in electric vehicles: A critical comprehensive survey", J. Energy Storage, 2021.

[7] M. F. Niri, T.M. Bui, T. Q. Dinh, E. Hosseinzadeh, T. F. Yu, and J. Marco,"Remaining energy estimation for lithium-ion batteries via Gaussian mixture and Markov models for future load prediction," J. Energy Storage, vol. 28, 2020, Art. no. 101271.

[8] M. Luzi, F. M. F. Mascioli, M. Paschero and A. Rizzi, "A white-box equivalent neural network circuit model for soc estimation of electrochemical cells", IEEE Transactions on Neural Networks and Learning Systems, vol. 31, pp. 371-382, 2020.

[9] Zhang M, Fan X. "Review on the State of Charge Estimation Methods for Electric Vehicle Battery, " World Electric Vehicle Journal. 2020.