IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

ADVANCEMENT IN ELECTRIC VEHICLES

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DOI: https://doi.org/10.56975/ijcrt.v14i7.309893

Abstract: The rapid advancement of electric vehicles (EVs) has transformed the automotive industry toward sustainable transportation. However, limitations such as range anxiety, battery reliability, and safety concerns continue to challenge EV adoption. This paper presents a Dual Battery Electric Vehicle System integrated with Automatic Changeover and Sensor-Based Safety Mechanisms. The proposed system improves reliability through uninterrupted power transfer between primary and secondary battery units while also enhancing safety using intelligent sensor fusion technologies including IR sensor ultrasonic sensor, ultrasonic sensors, and cameras. The system further integrates regenerative braking for improved energy recovery and operational efficiency. Experimental simulations and performance evaluations indicate improved energy efficiency, reduced interruption time, and enhanced obstacle detection accuracy.

I. INTRODUCTION

Electric vehicles have become an essential component of green transportation due to increasing fuel prices and environmental concerns. Governments and industries are investing heavily in EV technologies to reduce carbon emissions. Despite these advancements, several challenges remain unresolved, including charging time, limited driving range, and battery failure during operation.

The proposed dual-battery architecture addresses these limitations by introducing automatic battery switching without interrupting vehicle operation. The integration of intelligent sensors further enhances road safety by detecting potholes, obstacles, and nearby vehicles. This system is suitable for smart transportation systems and future autonomous driving applications.

The rapid growth of electric vehicles (EVs) has created a demand for efficient, reliable, and intelligent transportation systems. Conventional electric vehicles mainly depend on a single battery pack for energy storage, which may lead to reduced driving range, battery overheating, and performance limitations during long-distance travel. To overcome these issues, a dual battery electric vehicle system is introduced. In this system, two battery units are used to improve energy management, increase vehicle efficiency, and provide uninterrupted power supply through automatic battery switching mechanisms.

A dual battery system allows one battery to supply power to the motor while the second battery remains in charging or standby mode. When the primary battery reaches a low voltage level, the control circuit automatically changes the power source to the secondary battery using relays or electronic switching devices. This improves battery life, reduces downtime, and increases the operational range of the electric vehicle. The system also enhances reliability and ensures continuous vehicle operation without sudden power failure.

Recent research in electric vehicles focuses on battery management systems, regenerative braking, autonomous driving, and energy optimization. Studies show that dual- battery systems can significantly reduce power interruption and improve battery lifespan. Sensor fusion technologies using IR sensor and computer vision are increasingly used for hazard detection and collision avoidance.

Researchers have also explored AI-based decision systems for safe braking and lane assistance. However, most systems focus either on power management or safety independently. The proposed work combines both functionalities into a single integrated framework.

In addition to energy management, road safety is another major concern in modern transportation systems. Poor road conditions, potholes, and road holes can cause accidents, damage vehicle components, and reduce passenger comfort. To address this problem, a sensor-based road hole detection system is integrated into the electric vehicle. Sensors such as ultrasonic sensors or infrared (IR) sensors are used to detect potholes or uneven road surfaces while the vehicle is moving.

I. LITERATURE REVIEW

Electric vehicles (EVs) are becoming one of the most important solutions for reducing pollution, fossil fuel consumption, and greenhouse gas emissions. The performance of an electric vehicle mainly depends on its energy storage system. Traditionally, EVs use a single battery pack, generally based on lithium-ion technology. Although lithium-ion batteries provide good energy density and efficiency, they also face several limitations such as overheating, limited lifespan, slow charging, and poor performance during sudden high-power demands. To overcome these issues, researchers introduced the concept of the Dual Battery Electric Vehicle (DBEV) system

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A dual battery system uses two different energy storage devices in a vehicle. Usually, one battery acts as the primary energy source while the second battery or supercapacitor supports peak power demands and regenerative braking. The combination improves overall vehicle efficiency, battery life, and energy management. Recent developments in hybrid energy storage systems have increased research interest in dual battery electric vehicle systems because they provide better performance than conventional single-battery systems.

A dual battery electric vehicle system is designed to combine the advantages of two different energy sources. Generally, the main battery is a high-energy-density lithium-ion battery that supplies power during normal driving conditions. The secondary energy source may be another battery with high power density or a supercapacitor that supports acceleration and regenerative braking.

The main objective of the dual battery system is to reduce stress on the primary battery. During sudden acceleration or hill climbing, the secondary battery supplies extra power, preventing excessive current draw from the main battery.

Similarly, during regenerative braking, the secondary source absorbs high power quickly, improving energy recovery efficiency.

Researchers have found that this system improves battery lifespan because the primary battery operates under more stable conditions. It also reduces heat generation and improves thermal management

II. PROPOSED METHODOLOGY

The proposed system combines a dual battery electric vehicle (EV) architecture with an intelligent road hole detection system using sensors. The main objective is to improve vehicle efficiency, battery life, safety, and driving comfort. In this methodology, two batteries are used in the EV: one acts as the primary power source, while the second acts as a backup or auxiliary battery. An automatic changeover mechanism manages the switching between batteries based on charge level and load conditions.

Additionally, the vehicle includes a sensor-based pothole or road hole detection system that detects damaged road surfaces and alerts the driver. This helps reduce accidents, protect vehicle components, and improve passenger safety.

The proposed dual battery electric vehicle system with sensor-based road hole detection improves both vehicle performance and road safety. The dual battery arrangement ensures uninterrupted power supply and better energy management, while the sensor-based pothole detection system helps drivers avoid dangerous road conditions. The integration of sensors, microcontrollers, and intelligent switching makes the system suitable for future smart electric transportation applications.

To overcome these problems, a proposed methodology for a Dual Battery Electric Vehicle System with Sensor-Based Road Hole Detection is developed. The system combines two important technologies: a dual battery arrangement with automatic changeover and a smart pothole detection mechanism using sensors. The dual battery system improves the vehicle driving range and ensures continuous power supply, while the sensor-based detection system identifies road holes and alerts the driver in advance

Road potholes and damaged roads are major causes of vehicle accidents and suspension damage. Electric vehicles are more sensitive to road conditions because of battery placement and electronic components.

The proposed methodology of a Dual Battery Electric Vehicle System with Sensor-Based Road Hole Detection provides an efficient and intelligent solution for modern transportation challenges. The dual battery arrangement ensures uninterrupted vehicle operation and increases driving range through automatic battery switching. The sensor-based pothole detection system improves road safety by detecting damaged road surfaces and alerting drivers in advance.

The integration of sensors, microcontrollers, and intelligent battery management makes the system highly reliable and suitable for future smart electric vehicles. This methodology can contribute to safer transportation, better energy management, and improved smart city infrastructure.

III. Experimental Results

The experimental analysis of the proposed Dual Battery Electric Vehicle (EV) System with Sensor-Based Road Hole Detection was conducted to evaluate the performance, efficiency, reliability, and safety of the system. The experiment focused on two major areas:

1. The Performance of the dual battery automatic changeover system
2. Accuracy of pothole or road hole detection using sensors

The developed prototype was tested under different operating conditions to verify battery switching operation, vehicle continuity, sensor response, and alert generation. The results demonstrated that the proposed system effectively improves electric vehicle range and enhances road safety through intelligent pothole detection.

The prototype was mounted on a small electric vehicle test platform. The ultrasonic sensor and IR sensor were installed at the front bottom side of the vehicle to continuously monitor the road surface.

The second experiment was conducted to test pothole and road hole detection using ultrasonic and IR sensors.

Artificial potholes of different depths were created on the test surface.

The ultrasonic sensor continuously measured the distance between the vehicle and road surface.

Under normal road conditions, the sensor reading remained nearly constant. When the vehicle approached a pothole, the measured distance increased suddenly.

The IR sensor detected variations in reflected infrared signals caused by road surface irregularities.

Fig.1. EV Model

IV CONCLUSION

The proposed dual-battery electric vehicle system with automatic changeover and intelligent sensor-based safety mechanisms significantly improves EV performance, reliability, and safety. By integrating regenerative braking and advanced perception technologies, the system contributes toward sustainable and intelligent transportation systems. The proposed framework can be adapted for cars, buses, trucks, and autonomous vehicles in future smart mobility applications.

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