International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Design of Low Cost Transportation System for Rural Areas Using EV Technology

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ABSTRACT –

This paper presents a design proposal for a low-cost transportation system utilizing electric vehicle (EV) technology in rural areas. Rural regions often face challenges in terms of limited access to affordable and efficient transportation, resulting in reduced connectivity and socioeconomic development. The objective of this study is to develop a cost-effective transportation solution that addresses the specific needs of rural communities while leveraging the benefits of EV technology. The proposed design framework encompasses various aspects, including vehicle selection, charging infrastructure, and operational considerations. Firstly, an analysis of the transportation requirements and characteristics of rural areas is conducted to identify the most suitable EV type for the region. Factors such as terrain, road conditions, payload capacity, and range are considered to ensure the vehicles can meet the specific demands of rural transportation.

I. INTRODUCTION

Transportation is a fundamental aspect of socioeconomic development and plays a crucial role in connecting people, facilitating commerce, and improving quality of life. However, rural areas often face significant challenges in terms of limited access to affordable and efficient transportation options. The lack of adequate transportation infrastructure in these regions hampers connectivity, restricts access to essential services, and hinders economic growth.

In recent years, electric vehicle (EV) technology has emerged as a promising solution to address transportation challenges while reducing the dependence on fossil fuels and minimizing environmental impact. EVs offer advantages such as lower operating costs, reduced emissions, and quieter operation, making them well-suited for various transportation applications.

This paper focuses on the design of a low-cost transportation system for rural areas using EV technology. The objective is to develop an innovative and cost-effective solution that caters specifically to the unique requirements and constraints of rural communities. By leveraging the benefits of EVs, the aim is to enhance accessibility, improve connectivity, and promote sustainable development in rural regions.

Designing an effective transportation system for rural areas involves considering several key factors. Firstly, the selection of suitable EV types is crucial, taking into account factors such as terrain, road conditions, payload capacity, and range requirements. Understanding the specific transportation needs of rural communities is essential to ensure that the chosen vehicles can effectively serve the intended purposes.

In addition to vehicle selection, the establishment of a reliable and efficient charging infrastructure is critical. Rural areas often have limited access to electrical infrastructure, making it necessary to explore alternative charging methods. The design must consider the use of renewable energy sources, such as solar power, to provide sustainable charging solutions that can operate independently of the grid. Moreover, the placement of charging stations or the deployment of mobile charging units should be strategically planned to ensure convenient access for EV users in rural areas.

Operational considerations are equally important in designing a transportation system for rural areas. Intelligent fleet management techniques can optimize vehicle routing, minimize downtime, and maximize resource utilization. Incorporating advanced technologies, such as GPS tracking and data analytics, can enhance operational efficiency and enable real-time monitoring of the transportation system.

Furthermore, community engagement and participation are vital for the success of the transportation system. Understanding the local context, collaborating with stakeholders, and involving rural communities in the design and implementation process can ensure that the system meets their needs and preferences. User acceptance and adoption are crucial factors that determine the long-term sustainability and effectiveness of the transportation system.

To evaluate the proposed design, a case study will be conducted in a representative rural area. The study will assess the economic feasibility, environmental impact, and social benefits of implementing the EV-based transportation system. User feedback, stakeholder consultations, and iterative refinements will be incorporated to optimize the design and address any specific challenges or requirements.

II METHODOLOGY

Batter.y Pack: Electric cars are powered by a large battery pack, usually made up of numerous individual lithium-ion battery cells. The battery pack stores electrical energy and provides power to the car's electric motor.

Electric Motor: Electric cars use an electric motor instead of an internal combustion engine. The electric motor converts electrical energy from the battery into mechanical energy to drive the wheels of the vehicle. The motor generates torque and rotational motion, propelling the car forward.

Power Electronics: Power electronics play a crucial role in managing the flow of electrical energy between the battery pack and the electric motor. It includes components like inverters and converters that convert the direct current (DC) stored in the battery into alternating current (AC) to power the electric motor.

Controller and Software: Electric cars are equipped with a controller that manages the various components and systems within the vehicle. It controls the power distribution, monitors battery performance, and ensures optimal operation of the electric motor. Software systems also play a crucial role in managing the overall performance and efficiency of electric cars.

Charging Infrastructure: Electric cars need to be charged regularly to replenish the energy in their battery packs. Charging infrastructure includes charging stations, both public and private, where electric cars can connect and recharge. There are different types of chargers, including Level 1 (standard household outlet), Level 2 (dedicated charging station), and Level 3 (fast charging stations), offering varying charging speeds.

Range and Efficiency: The range of an electric car refers to the distance it can travel on a single charge. Factors affecting range include the capacity of the battery pack, driving conditions, speed, and use of auxiliary systems (e.g., air conditioning). Electric cars are becoming more efficient over time as advancements in battery technology and motor efficiency continue to improve.

III. BLOCK DIAGRAM

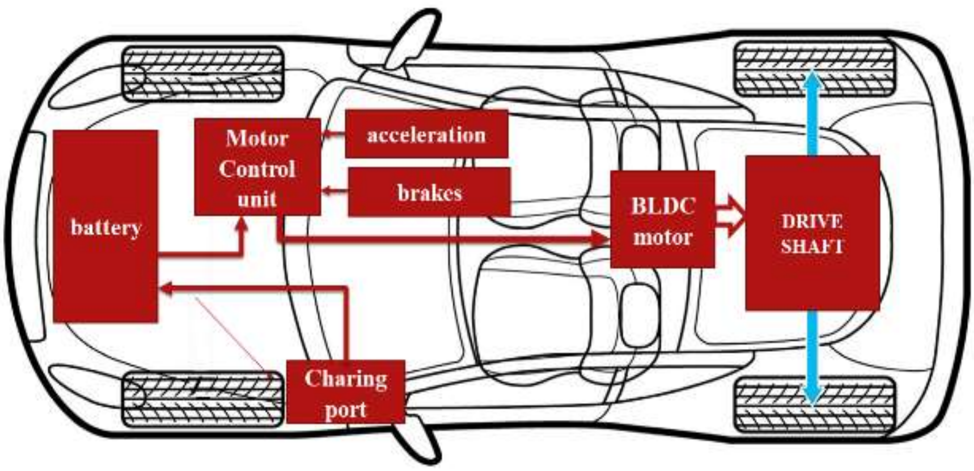

Fig 1:- block diagram

Motor control unit is the important part of this complete of the project as it performs the key role to give proper voltage and currents to rotate the motor with respective to the acceleration and brake.

The motor is a BLDC (Brush Less Direct Current) motor which is mostly used all of the electric vehicle as it has very high efficiency as compared to other electric motors for EV.

IV. CIRCUIT DIAGRAM

electric vehicle (EV) involves several components and processes that enable it to operate using electric power. The mainly all the component’s are inter connected with each other by which we can convert the electric power into mechanical rotary motion power with the help of motor and other components

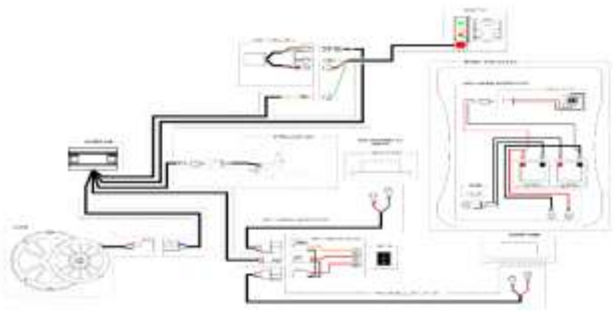

Fig 2:- Circuit Diagram

V. HARDWARE COMPONENTS: -

BLDC Motor:- A Brushless DC (BLDC) motor, also known as a electronically commutated motor (ECM) or synchronous DC motor, is a type of electric motor that operates based on the principles of electromagnetism. Unlike brushed DC motors that use brushes and a commutator for current switching, BLDC motors employ electronic commutation to control the flow of electrical current to the motor's windings.

Fig 3 :- BLDC Motor

lead–acid battery :- Lead-acid batteries are a type of rechargeable battery widely used for various applications, including automotive, marine, and uninterruptible power supply (UPS) systems. They consist of lead plates immersed in an electrolyte solution of sulfuric acid. Lead-acid batteries are known for their reliability, low cost, and relatively high energy density.

Fig 4:- lead–acid battery

BLDC motor controller:- also known as an electronic speed controller (ESC), is a device that controls the operation of a Brushless DC (BLDC) motor. The controller manages the timing and sequence of current flow to the motor's stator windings, ensuring proper commutation and efficient motor operation. It plays a crucial role in controlling the speed, direction, and torque of the motor. Sensor Input Interface: BLDC motors require position feedback to determine the rotor's position for commutation. The motor controller interfaces with position sensors such as Hall effect sensors, encoders, or resolver feedback systems. These sensors provide information on the rotor's position and speed, allowing the controller to determine the timing and sequence of commutation.

Fig 5 :- BLDC motor controller

Electronic pedal accelater :- An electronic pedal accelerator, also known as an electronic throttle control or drive-by-wire system, is an advanced technology used in modern vehicles to control the throttle opening and engine speed electronically, replacing the traditional mechanical throttle cable.

Fig 6 :- Electronic pedal accelater

Drive shaft:- In automotive design, an RR, or rear-engine, rear-wheel-drive layout places both the engine and drive wheels at the rear of the vehicle. In contrast to the RMR layout, the center of mass of the engine is between the rear axle and the rear bumper. Although very common in transit buses and coaches due to the elimination of the drive shaft with low-floor buses, this layout has become increasingly rare in passenger cars.

Fig 7:- Drive shaft

VI. RESULT:-

- Improved Accessibility: Implementing a low-cost transportation system using EVs in rural areas can enhance accessibility for residents. It can connect remote villages, provide transportation options for people without private vehicles, and improve access to essential services such as healthcare, education, and employment opportunities.
- Cost Savings: Electric vehicles generally have lower operating costs compared to traditional internal combustion engine vehicles. The use of EVs in a low-cost transportation system can result in reduced fuel and maintenance expenses, benefiting both the service provider and the users.
- Environmental Benefits: EVs produce zero tailpipe emissions, reducing air pollution and greenhouse gas emissions. Implementing EVs in rural areas can contribute to environmental sustainability, improving air quality and mitigating climate change impacts.

- Economic Opportunities: The design of a low-cost transportation system using EV technology can create economic opportunities in rural areas. It can generate employment through the establishment of charging infrastructure, vehicle maintenance, and operation of transportation services. Additionally, it can support local industries by utilizing renewable energy sources for charging, promoting energy self-sufficiency and rural development.
- Enhanced Mobility and Connectivity: EVs can provide reliable and efficient transportation, improving mobility and connectivity in rural areas. It can enable residents to access markets, social activities, and other services, reducing isolation and promoting social integration.

Fig 8 :- the prototype model

VI. CONCLUSION

In conclusion, the design of a low-cost transportation system for rural areas using EV technology holds immense potential to improve connectivity, accessibility, and overall development in rural communities. By leveraging the advantages of EVs and incorporating intelligent design principles, it is possible to create a sustainable transportation system that caters to the unique needs of rural areas. The subsequent sections of this paper will delve into the specific aspects of the design framework, highlighting the vehicle selection process, charging infrastructure considerations, operational strategies, and the results of the case study, providing insights into the viability and benefits of this approach.

ACKNOWLEDGMENT

This work was supported by the faculty members of Electrical and Electronics Engineering department, Guru Nanak Dev Engineering College Bidar. We thank project coordinator Mrs. Megha and Guide Mr. Durga prasad for providing facility

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