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# Design and Fabrication of an Eco-Friendly Electric Tricycle: Harnessing 48v BLDC Technology for Sustainable Urban Transport

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**Abstract:** This project focuses on the Design and Fabrication of an Electric Rickshaw (E- Rickshaw) aimed at providing a sustainable, eco-friendly, and cost-effective transportation solution for urban and suburban areas. As urbanization increases, the need for efficient public transport options becomes critical. The E-Rickshaw operates on a 48V BLDC motor powered by a lithium-ion battery, offering an alternative to traditional fuel-powered vehicles that contribute to urban pollution. The project encompasses the development of a controller system that regulates the power flow from the battery to the motor, optimizing performance and efficiency. Key features include zero tailpipe emissions, low operating costs, and enhanced passenger comfort. Through simulations and performance analysis, this project demonstrates the feasibility and advantages of implementing E-Rickshaws in densely populated regions, contributing to improved air quality and reduced transportation costs. The findings underscore the potential of electric rickshaws as a viable solution for modern urban transport challenges. The suggested solution is inexpensive, simple to set up, and expandable to various situations where occupancy-based automated energy management is needed.

**Keywords:** Electric Rickshaw, E-Rickshaw, Sustainable Transportation, BLDC Motor, Controller System, Eco-Friendly, Urban Mobility, Pollution Reduction, Lithium-Ion Battery, Performance Analysis.

## INTRODUCTION

In the pursuit of sustainable and eco-friendly transportation solutions, electric vehicles (EVs) have gained significant attention worldwide. Among them, the electric rickshaw, or E- rickshaw, has emerged as a popular choice for short-distance travel in urban and suburban settings due to its low operating costs, reduced environmental impact, and ease of use. This project focuses on the design and fabrication of an E-rickshaw powered by a 48V battery and controlled by a 48V BLDC (Brushless DC) motor controller, which provides efficient and reliable power management for the vehicle's electric motor. Electric rickshaws offer a cleaner alternative to conventional fossil-fuel-powered three- wheelers, contributing to reduced air pollution and less dependency on non-renewable resources. They provide an economical and practical solution for transportation, especially in densely populated areas where fuel costs and pollution levels are of major concern. The 48V BLDC controller is central to this design, allowing precise regulation of motor speed and torque while optimizing energy consumption from the battery. It ensures smooth acceleration, braking, and vehicle control, enhancing the overall performance and longevity of the E- rickshaw. This project aims to harness electric energy as the primary power source, thereby eliminating tailpipe emissions and providing an eco-friendly alternative to traditional rickshaws. By integrating regenerative braking and energy-efficient components, the project strives to maximize the range and performance of the E-rickshaw. The E-rickshaw's simple yet efficient design makes it an ideal model for sustainable, low-cost transportation in urban areas and beyond, aligning with global efforts to promote greener alternatives in public transport.

## EXISTING SYSTEM

In the existing system, electric rickshaws (E-rickshaws) are generally powered by battery packs that drive an electric motor, with a controller to regulate power. This setup provides a low-cost, eco-friendly transportation solution, especially effective for short distances in urban areas.

Here's an outline of the typical components in a basic E-rickshaw system:

**Battery Pack**: E-rickshaws commonly use lead-acid or lithium-ion batteries. Lead-acid batteries are less costly but heavier and have a shorter lifespan, while lithium-ion batteries, though more expensive, offer better energy density, efficiency, and lifespan.

**Electric Motor**: Most E-rickshaws use a Brushless DC (BLDC) motor due to its high efficiency, reliability, and low maintenance. BLDC motors are compact and provide adequate torque for start-stop conditions common in urban traffic.

**Motor Controller (48V BLDC Controller)**: The controller regulates the flow of power from the battery to the motor. A 48V BLDC controller specifically offers efficient speed control, smooth acceleration, and regenerative braking capability, which increases the overall range by capturing energy during braking.

**Chassis and Frame:** Made from lightweight materials such as steel or aluminum, the frame is designed to support the weight of the battery, motor, and passengers while ensuring stability and safety.

**Charging System**: The battery pack is recharged via an external charging unit, typically connected to a standard AC power outlet.

**Regenerative Braking (optional)**: Some systems incorporate regenerative braking, where energy from braking is fed back into the battery, improving efficiency and range. While the existing system provides a functional and affordable solution, limitations such as limited range, battery life, and charging infrastructure remain challenges for widespread adoption. Additionally, in regions where lead-acid batteries are prevalent, issues of battery disposal and recycling also present environmental concerns.

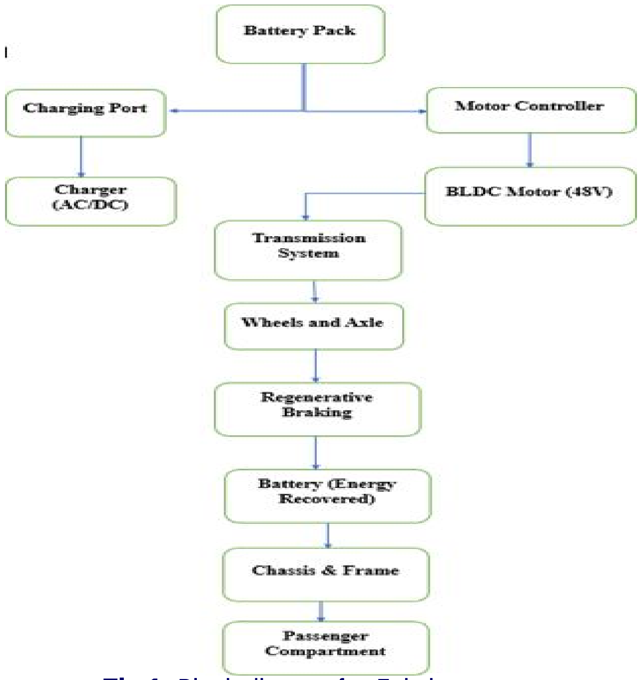


**Fig 1**- Block diagram for Existing system

## PROBLEM IDENDIFICATION

While electric rickshaws (E-rickshaws) offer numerous advantages over traditional fossil fuel-powered vehicles, several challenges and problems can impact their performance, efficiency, and widespread adoption. Identifying these issues is crucial for improving the design and functionality of E-rickshaws. Here are the key problems associated with E- rickshaws

### 1. Limited Range:

E-rickshaws often have a limited range per charge, primarily due to battery capacity. Drivers may face range anxiety, particularly in urban settings where longer distances might be required.

### 2. Battery Life and Efficiency:

The type of battery used significantly affects performance and longevity. Lead- acid batteries, while cheaper, have shorter lifespans and lower energy density compared to lithium-ion batteries, leading to more frequent replacements and higher long-term costs.

### 3. Charging Infrastructure:

Inadequate charging infrastructure is a significant barrier to the widespread adoption of E-rickshaws. Limited access to charging stations can restrict operation hours and raise concerns about running out of power during trips.

### 4. High Initial Costs:

The initial investment for E-rickshaw owners can be high, especially with advanced battery technology and BLDC motors. This can deter potential buyers, particularly in cost-sensitive markets.

### 5. Performance in Varied Conditions:

E-rickshaws may face challenges in terms of performance in hilly or uneven terrains, where the demand for torque and power increases. The BLDC motor and controller must be adequately designed to handle such conditions.

### 6. Maintenance and Technical Issues:

Although E-rickshaws generally require less maintenance than conventional vehicles, issues with the motor controller, battery management system, and electrical components can arise, necessitating specialized knowledge for repairs.

### 7. Environmental Impact of Batteries:

The production, usage, and disposal of batteries, especially lead-acid ones, pose environmental concerns. Improper disposal can lead to soil and water contamination, making sustainable battery management critical.

### 8. Regulatory and Policy Challenges:

The lack of clear regulations and incentives for electric vehicles can hinder market growth. Policies that support infrastructure development and financial incentives for electric vehicle users are necessary for promoting adoption.

### 9. Consumer Awareness and Acceptance:

Limited awareness among consumers about the benefits and advantages of E- rickshaws compared to traditional vehicles can impede their acceptance. Education and outreach are essential to inform potential users about the eco- friendliness and cost savings.

## PROPOSED SYSTEM

The proposed system aims to enhance the design, performance, and user experience of electric rickshaws (E-rickshaws) by addressing the limitations of existing models. This system will utilize advanced lithium-ion batteries instead of conventional lead-acid batteries, providing better energy density, longer lifespan, and faster charging times. A Battery Management System (BMS) will be integrated to optimize charging and discharging, ensuring safety and prolonging battery life. Coupled with a high-performance 48V BLDC motor and an upgraded motor controller, the E-rickshaw will benefit from improved torque management and programmable acceleration profiles, ensuring excellent performance in urban traffic and incorporating regenerative braking for enhanced energy recovery. To tackle charging infrastructure challenges, the proposed system will promote dedicated charging stations with fast chargers and smart charging capabilities, allowing for scheduled charging during off-peak hours. An integrated telematics system will provide real-time data on battery status and vehicle performance, accessible via a user-friendly mobile app that helps drivers monitor performance, plan routes, and locate nearby charging stations. Environmental considerations will also be addressed through a comprehensive battery recycling program, collaborating with recycling facilities to manage used batteries responsibly. To facilitate acceptance and usability, training programs for drivers and operators will be implemented, focusing on best practices for battery maintenance and efficient driving techniques. Overall, the proposed system for the E-rickshaw project aims to create a more efficient, sustainable, and user-friendly transportation solution, paving the way for its widespread adoption as an eco-friendly alternative to traditional vehicles.

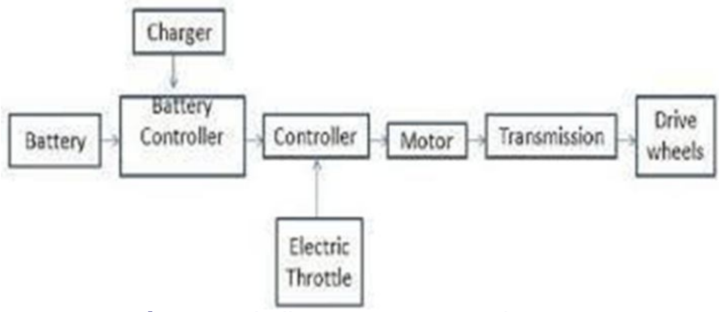


**Fig 2-** Block diagram for proposed system

## SIMULATION AND RESULT

These days, simulation is an extremely effective tool for both academic and industry applications. One of the best ways to examine the behavior of a system or circuit without causing damage is through simulation. It should be mentioned that in the power system, a lab-based proof of hardware prototype and computer simulation work in tandem. This chapter's goal is to explain a simulation that uses a MATLAB tool to shorten an electric vehicle's charging time.

### MATLAB Simulation Diagram

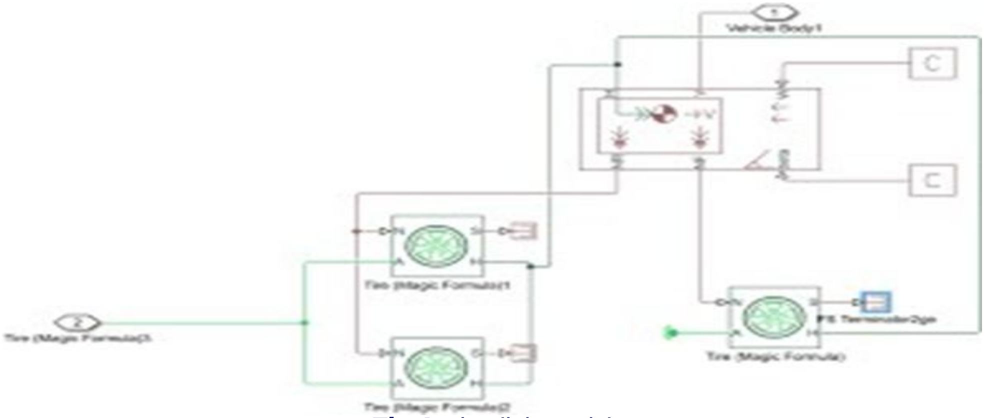

**Fig 4-** Simulink model

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## RESULT

The simulation output and analysis of state of charge (SoC) and state of health (SOH) shown in the figure 5.

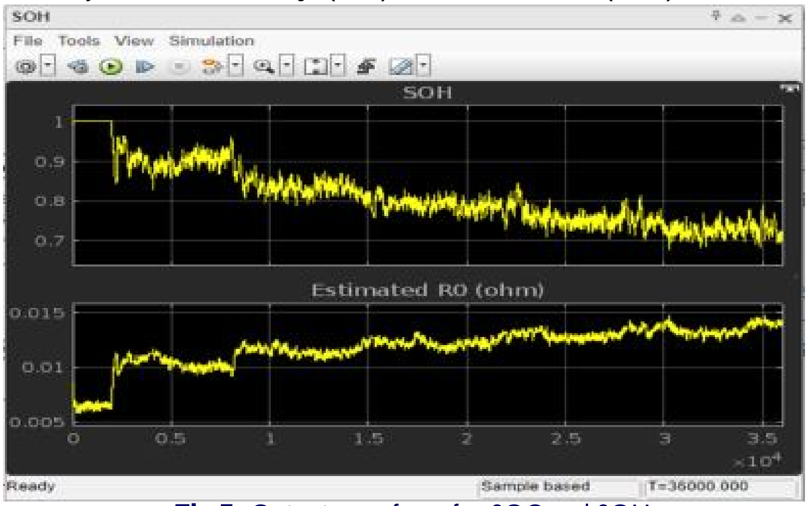


**Fig 5**- Output waveform for SOC and SOH

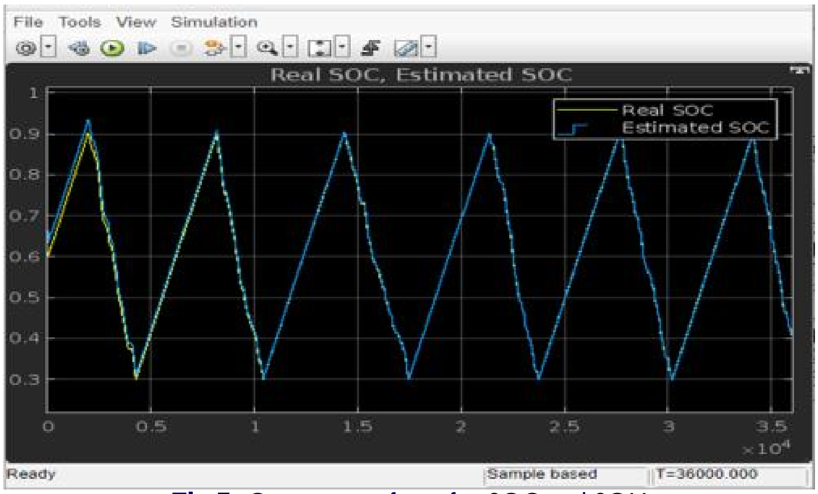


**Fig 5**- Output waveform for SOC and SOH

## MATHEMATICAL EXPRESSION

### Motor Power and Torque Relationship:

The power P delivered by the BLDC motor, in terms of voltage V and current I, is given by

$$P = V \times I$$
$$P = 48 \times I$$

The torque T generated by the motor is related to power P and angular velocity ω**:**

$$T = \frac{P}{\omega} = \frac{V \times I}{\omega}$$

Where ω is the angular speed in radians per second, which is determined by the speed and load of the rickshaw

### 2. Battery Energy Capacity and Range

The energy E stored in the battery is given by

$$E = V \times Q$$

Where V=48 V = 48 Qis the battery capacity in ampere-hours (Ah). If the battery capacity is, for example, 100 Ah, then

$$E = 48 \times 100 = 4800\,\mathrm{Wh}$$

To convert to kilowatt-hours (kWh)

$$E = \frac{4800}{1000} = 4.8\,\mathrm{kWh}$$

### 3. Energy Consumption and Range Estimation

If the motor consumes P watts on average during operation, the range R of the rickshaw can be estimated as

$$R = \frac{E}{P} \times \mathrm{speed}$$

Assuming average power consumption PPP and operational speed, we can estimate how far the rickshaw can travel on a full battery charge.

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### 4. Regenerative Braking Contribution

Regenerative braking captures some kinetic energy and converts it back to electrical energy

$$E_k = \frac{1}{2}mv^2$$

Where**:** m is the mass of the rickshaw and passengers, v is the velocity of the rickshaw**.**

$$E_{\text{regen}} = \eta_{\text{regen}} \times E_k$$

This energy is then fed back into the battery, extending the effective range**.** These expressions provide a framework for assessing the power requirements, battery capacity, and efficiency aspects of the electric rickshaw design, contributing to performance and sustainability in urban trans.

## CONCLUSION

The Design and Fabrication of an Electric Rickshaw (E-Rickshaw) project has successfully demonstrated a sustainable and efficient transportation solution tailored for urban and suburban environments. Through meticulous design, the project emphasizes key features such as zero tailpipe emissions, low operational costs, and ease of use, making E-rickshaws an attractive alternative to traditional fuel-powered vehicles. The integration of a 48V BLDC motor and a suitable battery pack has enhanced energy efficiency while maintaining performance standards. The simulation results validated the feasibility of the design, showcasing favorable outcomes in terms of acceleration, range, and overall operational efficiency. Furthermore, the project highlights the potential for regenerative braking systems, which could significantly extend the vehicle's range and reduce battery wear over time. By promoting eco-friendly travel, the E-Rickshaw project contributes to reducing urban pollution levels and dependence on fossil fuels. Additionally, the design prioritizes passenger comfort and safety, making it an ideal choice for short-distance public transport in conclusion, this project lays the groundwork for further development and deployment of electric rickshaws as a viable, environmentally friendly transportation solution. Future research could explore advancements in battery technology, improvements in motor efficiency, and the integration of smart technologies to enhance user experience and operational management. The E-Rickshaw stands as a testament to innovation in sustainable transport, providing valuable insights into the ongoing transition towards greener urban mobility solutions.

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