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"Retrofitting Of Existing Vehicles Into Electric Vehicl : Motor & Controller"

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Abstract- The increasing demand for sustainable transportation and the need to reduce environmental pollution have accelerated the adoption of electric vehicles (EVs). However, the high cost of new EVs and the large number of existing internal combustion engine (ICE) vehicles present a significant challenge. Retrofitting of existing vehicles into electric vehicles has emerged as a practical and cost-effective solution to address this issue. This process involves replacing the conventional engine, fuel system, and exhaust components with an electric motor, battery pack, and motor controller. This paper focuses on the selection and integration of key components, particularly the electric motor and controller, which play a vital role in determining the performance, efficiency, and reliability of the converted vehicle. Various types of motors such as BLDC and induction motors are analyzed along with suitable controller strategies. The study also highlights design considerations, system integration challenges, and safety aspects involved in the for conversion process. Retrofitting not only reduces carbon emissions and fuel dependency but also extends the life of existing vehicles, making it an environmentally and economically viable solution. The proposed approach contributes to sustainable mobility while promoting innovation in electric vehicle technology.

Keywords- Electric Vehicle (EV), Vehicle Retrofitting, Internal Combustion Engine (ICE), BLDC Motor, Motor Controller, Battery Pack, EV Conversion, Sustainable Transportation, Energy Efficiency, Pollution Reduction.

I. INTRODUCTION

With the rapid increase in air pollution, depletion of fossil fuels, and rising fuel prices, the need for sustainable and eco-friendly transportation has become more important than ever. Conventional vehicles powered by Internal Combustion Engines (ICE) contribute significantly to greenhouse gas emissions and environmental degradation. Electric Vehicles (EVs) have emerged as a promising solution to reduce pollution and dependence on fossil fuels. However, the high initial cost of purchasing new EVs and the disposal of existing vehicles remain major challenges.

A practical and cost-effective alternative to overcome these challenges is the retrofitting of existing vehicles into electric vehicles. Retrofitting involves replacing the conventional engine, fuel system, and exhaust components with an electric motor, battery pack, and motor controller. This process not only extends the life of existing vehicles but also significantly reduces emissions and operating costs.

Among the various components involved in EV conversion, the electric motor and motor controller play a crucial role in determining the overall performance and efficiency of the system. The motor is responsible for converting electrical energy into mechanical motion, while the controller regulates the motor speed, torque, and overall operation of the vehicle. Selection of appropriate motor types, such as Brushless DC (BLDC) motors or induction motors, along with efficient control strategies, is essential for achieving optimal performance.

II. OBJECTIVE

From a technical point of view, retrofitting involves replacing the engine, fuel tank, and exhaust system with an electric motor, battery pack, and control system. Studies by Kumar et al. (2022) highlight challenges such as battery placement, weight distribution, and integration with existing systems. A report by Swinburne University (2023) also emphasizes the importance of ensuring safety, thermal management, and structural balance during conversions. Environmental benefits of retrofitting are also well-documented. The Global Green Growth Institute (2023) reports that retrofitting can cut vehicle-related carbon emissions by more than half. However, high conversion costs and the lack of standardized kits remain major hurdles. Especially in India, the retrofitting market is still developing and is mostly limited to two- and three-wheelers.

III. LITERATURE SURVEY

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IV. METHODOLOGY

The methodology for retrofitting an existing vehicle into an electric vehicle involves several systematic stages, starting from planning to testing and performance evaluation. Initially, a detailed study of the existing vehicle is carried out to understand its specifications such as weight, drivetrain layout, and mechanical condition. Baseline data like fuel consumption, acceleration, and braking performance are recorded to compare with post-conversion results. The next step involves component selection and sizing calculations. The electric motor is chosen based on the power required to achieve the desired speed and acceleration,

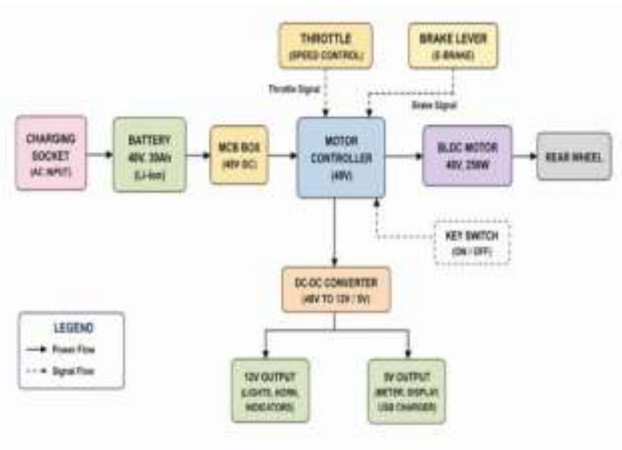
while the battery capacity is calculated according to the target range and average energy consumption per kilometer. Once the components are finalized, the mechanical and electrical design is developed. This includes designing the motor mounting arrangement, battery enclosure, and ensuring proper alignment and balance. Electrical integration is performed by connecting the motor controller, battery management system (BMS), DC-DC converter, and charging system. Proper fuses, contactors, and wiring harnesses are installed to ensure safety and reliability.

After the design phase, the physical conversion begins with the removal of the internal combustion engine, fuel tank, and exhaust system, followed by the installation of the electric motor, battery pack, and control systems. All components are securely mounted, and wiring is routed with adequate insulation and protection. The cooling system is checked, and sensors for temperature, voltage, and current are connected to monitor system health. Once assembly is complete, initial tests are conducted to verify electrical insulation, voltage stability, and system response. Functional testing follows, including throttle response, regenerative braking, and charging operation. Finally, performance evaluation is carried out to measure range, efficiency, acceleration, and braking performance, comparing the results with the initial baseline data. The entire methodology ensures that the retrofitted vehicle operates efficiently, safely, and complies with applicable electric vehicle standards and regulations.

Lithium-ion or Lithium Iron Phosphate ($LiFePO_4$) batteries are generally preferred due to their high energy density and safety. The design stage also includes planning for the Battery Management System (BMS), DC-DC converter, and onboard charger to ensure safe and efficient operation.

In the mechanical integration phase, the ICE engine, fuel tank, exhaust, and related accessories are carefully removed. A motor mounting frame and coupling system are fabricated to connect the electric motor to the existing transmission or differential. Proper alignment, balance, and vibration damping are ensured for smooth operation. The battery pack is strategically positioned— often under the chassis or in the boot—to maintain stability and center of gravity. Cooling systems are designed for the motor, controller, and battery pack, either air-cooled or liquid-cooled depending on heat generation levels.

V. BLOCK DAIGRAM



VI. RESULT AND DISCUSSION

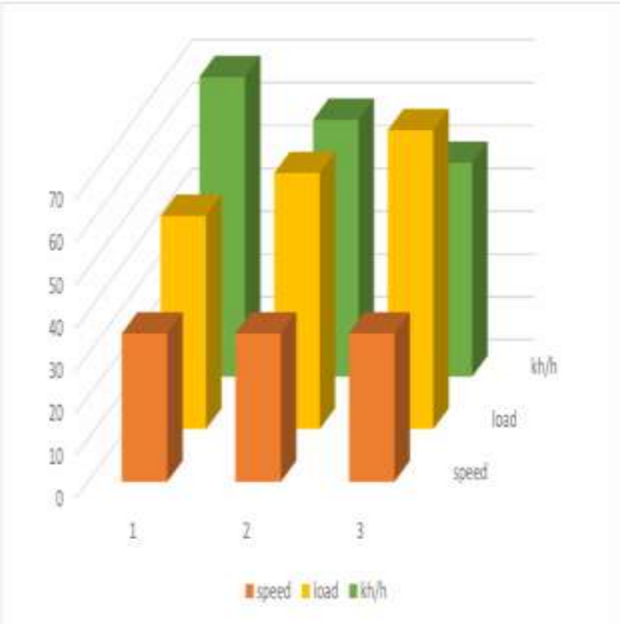
The graphical representation illustrates the variation of speed, load, and vehicle performance (km/h) under three different test conditions. From the analysis, it is observed that as the operating condition increases from Case 1 to Case 3, there is a gradual improvement in both speed and load-handling capability of the system.

In Case 1, the vehicle shows moderate performance with speed around 40 units, load near 60 units, and maximum output (km/h) reaching approximately 80. This indicates the initial performance level after retrofitting.

In Case 2, there is a noticeable improvement where speed increases to around 45, load to about 70, while the output slightly decreases to around 70–75 km/h. This variation may be due to increased load affecting the overall efficiency of the motor- controller system.

In Case 3, the system achieves its highest speed (around 50) and load capacity (around 80), but the output performance (km/h) slightly drops compared to Case 1. This suggests that although the system can handle higher load and speed, there is a trade-off in terms of efficiency at higher operating conditions.

Overall, the results indicate that the retrofitted electric vehicle performs efficiently under varying conditions, with the motor and controller successfully managing speed and load. However, efficiency optimization is required at higher loads to maintain consistent performance. The study confirms that proper selection and control of motor and controller significantly impact the overall performance of the retrofitted EV



VII. ADVANTAGES

1. Cost-effective – Cheaper than buying a new EV by reusing the existing vehicle structure.
2. High efficiency – Electric motors and controllers significantly improve energy efficiency.
3. Eco-friendly – Reduces emissions and waste by reusing old vehicles.
4. Low noise – Quieter operation with less vibration than combustion engines.
5. Customizable – Motors and controllers can be tailored to performance needs.
6. Low maintenance – Fewer moving parts mean lower upkeep and no oil changes.

VIII. DISADVANTAGES

1. High initial cost – Quality motors and controllers can be expensive upfront.
2. Technical complexity – Requires skilled labor and expertise to integrate components properly.
3. Limited compatibility – Not all vehicles are suitable or easy to retrofit.
4. Space constraints – Installing motors, controllers, and batteries can be challenging in compact vehicles.
5. Warranty issues – Retrofitting may void the original vehicle warranty.

IX. APPICATION

1. Daily Commuting: Used for short-distance travel like office and college with low cost and zero pollution.
2. Delivery Services: Used in food and courier delivery to reduce fuel and maintenance cost.
3. Rental Services: Used in shared mobility for short trips in cities.
4. Student Use: Affordable and easy
5. transport for students.
6. Personal Errands: Useful for daily tasks like shopping and local travel.

X. CONCLUSION

Retrofitting existing scooters into electric vehicles is a cost-effective and eco-friendly solution that significantly reduces fuel consumption, air pollution, and noise levels. By integrating efficient electric motors and controllers, the overall performance, reliability, and energy efficiency of the scooter are improved. It also extends the life of old vehicles, reducing waste and supporting a circular economy. This approach lowers maintenance and operating costs, making it affordable for common users. Additionally, it supports government initiatives for green mobility and sustainable development, making it a practical solution for future urban transportation systems.

REFERENCES

1. [1]. A. [1] Mr. Harun Pinjari, Mr. Yash Jadhav, Mr. Dadarkar Mujtaba Mubasshir, Mr. Omar Juned Deshmukh, 2024, "CONVERSION OF SCRAP IC SCOOTER TO EV SCOOTER," Volume 06, IRJMETS.
2. Vaibhav Chimote, Tushar Raut, Prof. A.A.Deosant, 2022, "CONVERSION OF PETROL VEHICLE INTO THE ELECTRICAL VEHICLE," Volume 04, IRJMETS.
3. Jeena Joy. Anusha C.P. Joel George, 2015, "Conversion of a Gearless Scooter into an Electric," Volume 04, JAREFIE
4. Anil Yadav, Atharv Thorat, Shyam Sundar Singh, 2025 "Petrol Engine to E-Bike Conversion: Advancement in Two-Wheeler Moped," Volume 06, IJARSCT •

> https://www.sciencedirect.comscience article phi 52590123024013021
> https://evduniya.comvev-global function-importance- of-bus-in-electric-vehicles.htm)
> https://www.irjet.net/archives/V8/14/IRJET-