

Electric Powertrain Integration to a Conventional Two-Wheeler using chain drive

Mr.K.Saravanakumar¹, Dr.D.Rekha², Mr.S.Isvarah Achintya³, Mr.S.R. Tarun Sabari⁴, Mr.B.Gowtham Saideep⁵, Mr.K.Brinsley Rohan⁶, N.Vengadesh⁷

¹Lecturer, PSG Polytechnic College,

²Lecturer (Sr. Gr), PSG Polytechnic College

^{3,4,5,6}Student, PSG Polytechnic College

Abstract: This project's main goal is to turn a traditional motorcycle into an electric vehicle by designing and building a mid-drive electric drive system. A BLDC mid-mounted motor, lithium battery pack, motor controller, throttle unit, DC–DC converter, charger, and protection devices make up the electric powertrain that will replace the internal combustion engine. The goal is to comprehend real-world electric vehicle integration while keeping efficiency, safety, dependability, and real-time operating behaviour in mind. The engine assembly must be removed in order to install the electric drive components after making the necessary mechanical and electrical adjustments. A chain drive system is used to transfer power to the rear wheel after a mid-mounted BLDC motor is chosen and installed on the frame.

The primary energy source is a 48 V battery pack, and motor speed and torque are controlled by an electronic motor controller in response to throttle input. A dedicated EV charger for safe battery charging, an MCB for circuit protection, and a DC–DC converter for low-voltage auxiliary loads are examples of supporting subsystems that are included to guarantee correct operation. Throughout operation, the controller receives electrical energy from the battery and uses it to provide the motor with controlled power based on input from the rider. To confirm performance, responsiveness, and dependability, the system is put together and tested in various operating environments. In a real-world setting, this project offers practical experience with electric vehicle conversion, component selection, system integration, and overall drivetrain performance.

Keywords: Hybrid vehicle; Electric vehicle; ABS; Internal Combustion Engine.

I. INTRODUCTION

Urbanization and a reliance on traditional motorcycles have amplified fuel consumption and emissions, raising

environmental and economic alarms. Electric powertrain integration offers a practical method for converting conventional vehicles to electric power by replacing the internal combustion engine with an electric drive system. This strategy prioritizes the preservation of the original vehicle's architecture, including the chassis, suspension, and, when feasible, the transmission. By minimizing alterations to the vehicle's structure, this approach streamlines the conversion process and reduces manufacturing complexity. Specifically, the integration of a mid-mounted electric motor into a traditional motorcycle, utilizing a chain drive transmission system, leverages the chain drive's inherent advantages of mechanical simplicity, dependability, straightforward maintenance, and compatibility with existing sprocket designs commonly found in two-wheeled vehicles.

The integrated electric powertrain utilizes a battery pack as its main energy source, which powers a mid-mounted brushless DC motor responsible for propulsion. A motor controller regulates the speed and torque of the motor, responding to rider input via a throttle interface. Electrical energy from the battery is delivered to the motor through the controller, which modifies the output according to the throttle demand. The motor's mechanical power is then transmitted to the rear wheel via a chain drive, facilitating movement. A DC–DC converter and various protection devices are included to maintain stable operation and ensure electrical safety throughout the system.

A mid-mounted motor configuration offers several advantages, primarily stemming from its balanced weight distribution and efficient use of existing drivetrain geometry. This arrangement facilitates

improved torque multiplication through sprocket ratio selection, enabling better adaptability to varying load conditions. Furthermore, the retention of a chain drive mechanism ensures smoother power transmission and allows for a more seamless integration process, minimizing the need for significant frame redesign. This research focuses on the practical conversion of a vehicle to electric power, stressing component compatibility and mechanical mounting techniques.

The conversion process involves removing the existing engine assembly and installing an electric motor using appropriate mounting supports. Careful consideration is given to optimizing battery placement and managing controller wiring. Proper alignment of the chain drive system is crucial for efficient power transfer. The study also includes a thorough performance evaluation to assess power delivery, responsiveness, and operational reliability across diverse operating conditions. The integration of an electric powertrain into conventional two-wheelers presents a promising and practical approach to transitioning towards electric mobility. This method leverages the existing transmission architecture of traditional motorcycles and scooters, offering a blend of mechanical compatibility and electrical performance. The proposed system facilitates the conversion of gasoline-powered two-wheelers into electric vehicles by replacing the internal combustion engine with an electric motor and battery pack, while retaining the original gearbox and drive chain. This design choice allows for a cost-effective conversion process, as it minimizes the need for extensive modifications to the vehicle's frame and structure.

II. LITERATURE SURVEY

[1] Hemant Shete et al., "Design and Analysis of Retrofitted Two-Wheeler Electric Vehicle," IARJSET, the study details the design considerations and performance analysis involved in converting a standard two-wheeled vehicle to an electric vehicle. Key areas of focus include the selection of appropriate battery technology, the integration of an electric motor, and necessary structural adaptations to the original vehicle frame. The research emphasizes the potential for enhanced energy efficiency and a decrease in exhaust emissions through this conversion process. Furthermore, the paper assesses the overall system performance of the retrofitted electric two-

wheeler in real-world operating scenarios.

[2] K Saravanakumar et al., "The project signifies the new hybrid technology for the emission standards and the eco friendliness. It offers both range and mileage for the users for a long run emitting lesser emission. The ABS helped to increase the braking efficiency on the wet surfaces and drastically reduced the skidding and loss of stability.

[3]F. Hoefl, "Internal Combustion Engine to Electric Vehicle Conversion," Transportation Research Interdisciplinary Perspectives, The paper delves into the multifaceted landscape of vehicle electrification, specifically examining the feasibility of converting existing vehicles. It presents an evaluation of the environmental benefits stemming from such conversions, alongside a consideration of the relevant regulatory frameworks that govern the process. Furthermore, the study addresses the technological limitations and challenges inherent in retrofitting vehicles with electric powertrains, providing a comprehensive overview of the subject matter.

[4]Raghendra Singh Patel, "Scope of Retrofitting ICE Vehicle into Electric Vehicle," International Journal of Science, Engineering and Technology, this study investigates the technical and economic viability of converting internal combustion engine (ICE) vehicles to electric vehicles (EVs). The research focuses on the potential for significant emission reduction through this conversion process, alongside improvements in energy efficiency. Furthermore, the study highlights the sustainability advantages of [repurposing existing vehicles, offering a pathway to reduce waste and promote a circular economy within the automotive industry.

[5]A. Kumar et al., "Design and Analysis of Retrofitted Two-Wheeler," IARJSET, this study explores the structural modifications and drivetrain integration. A key challenge lies in the mechanical mounting of the electric motor and battery pack, often requiring custom fabrication to ensure secure and stable integration within the existing vehicle chassis. Furthermore, maintaining system stability throughout the conversion process presents considerable difficulties, demanding careful consideration of weight distribution, suspension adjustments, and the potential for increased stress on original components.

[6]S.Hegde et al., “Design and Development of Retrofitting on Bikes,” IRJMETS, this paper details the conversion of traditional combustion engine motorcycles to electric-powered versions, outlining key design considerations. The process emphasizes optimal battery placement within the existing motorcycle frame to maintain balance and handling. Motor mounting strategies are explored, considering factors like torque transmission and structural integrity. Furthermore, the paper highlights essential electrical safety measures implemented to protect riders and ensure reliable operation of the converted electric motorcycle.

III. METHODOLOGY

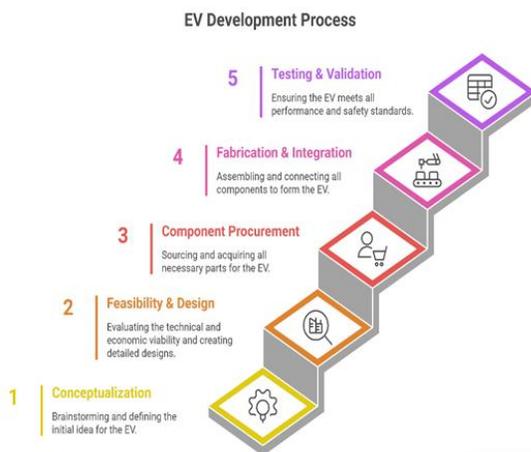


Fig.3.1 Methodology

The practical possibility of the project work has been carried out with concept possibility, feasibility and fabrication as shown in Fig.3.1

IV. COMPONENT DESCRIPTION

The component description serves as a detailed overview of the individual parts that make up the whole. This section will outline the key components, such as the battery, mid-drive motor, motor controller, throttle unit, chain drive mechanism, DC-DC converter, EV charger, and protective devices. The battery's role in energy storage and supply, the mid drive motor's contribution to propulsion, the controller's task in managing power distribution, and the DC-DC converter's importance in ensuring equipment safety. Each component is integral to the performance, efficiency, and safety of the electric two-

wheeler, making this section crucial for understanding the vehicle's innovative design.

4.1 Internal Combustion Engine:

The Kawasaki Bajaj Boxer, fig 3.1, was a commuter motorcycle manufactured in India by the Indian division of the Kawasaki-Bajaj partnership.

Vehicle Specifications:

Engine Displacement (cc) – 99.2 cc Mileage - 55 Kmpl

Engine Type - 4 Stroke, SI Engine Number of Cylinders -1

Fuel Supply System - Carburetor Maximum Power – 7.9 Bhp @7000 Rpm Maximum Torque – 8.5

Nm@5000 Rpm Wheel Base – 1235 mm

Overall Width – 770 mm Overall Length – 1970 mm Overall Height – 1065 mm Ground Clearance – 150

mm Kerb weight – 109 kg

Fuel tank capacity – 8 Liters

Brake system:

Front brake type – Drum

Rear brake type – Drum



Fig.4.1 Two-Wheeler

4.2 BLDC Mid-Drive Motor

The core of the electric powertrain lies in the mid-mounted BLDC motor, converting 48V battery power into mechanical energy. Unlike hub motors, this mid-drive design is frame-mounted, utilizing a chain drive to power the rear wheel. This arrangement, fig 4.2, optimizes weight distribution, amplifies torque via sprocket selection, and integrates seamlessly with standard two-wheeler frames. The motor comprises a stator with copper windings, a rotor with permanent magnets, a central shaft, precision bearings, and a

heat-dissipating aluminum housing for structural support. An electronic controller energizes the stator windings, generating a rotating magnetic field that interacts with the rotor's magnets, producing continuous rotation. Torque is then transferred to the rear wheel via a sprocket and chain. Current flow, and thus speed and torque, are managed by the controller based on throttle input. The brushless operation of the motor results in less maintenance, greater efficiency, reduced noise, and increased dependability compared to traditional brushed motors.

Mid-Drive Motor Specification

Power (Continuous Power): 0.8kW

Type: DC Brushless Gear Motor

Wheel Size: 17-inch Speed: 35 km/h Torque: 25 - 30 Nm

Max. Working Temperature: -10°C to +40 °C

Waterproof Grade: IP40 Weight: 7 - 8kg

Efficiency:85%



Fig.4.2 BLDC Mid – Drive Motor

4.3 Lithium-Ion Battery

The battery pack serves as the energy storage unit for the electric motor. Lithium-ion batteries, renowned for their high energy density and quick charging capabilities, are commonly used. The battery's voltage and capacity are selected to meet the power demands of the vehicle, ensuring a balance between range and performance. Advanced Battery Management Systems (BMS) are integrated for efficient power distribution and thermal management.

Fig.4.3 illustrates the lithium-ion battery which is favored for its extended range, lightweight design, faster charging, durability, high discharge rate, and maintenance convenience, making it ideal for

enhancing the vehicle's efficiency and environmental sustainability.



Fig.4.3 Battery

Lithium Ion Battery Specification Nominal Voltage – 48V

True Capacity – 20AH at 0.2C discharge Watt hr. – 962Wh • Weight – 15 Kg

Battery Dimensions (L*W*H) – 253 mm x 156 mm x 171 mm

Full Charged Voltage – 54.6V Discharge Cut-off

Voltage – 37V Standard Charging Current – 6A Max Charging Current – 10A

Max Continuous Discharge Current – 30A

Peak Discharge Current – 60A (for few milli seconds)

4.4 Controller

A BLDC motor controller regulates the speed and torque of the motor and it can also start, stop, and reverse its rotation. Its major components comprise an armature or rotor made of permanent and in many cases neodymium magnets and a stator with windings that create a magnetic field when energized. The rotor's magnets and stator's windings provide the rotation of the motor.

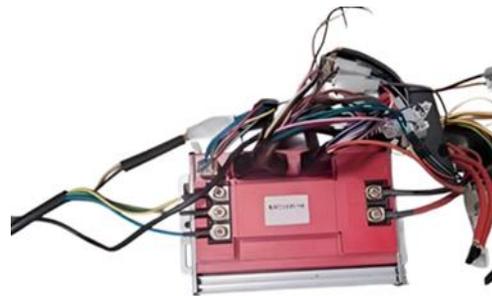


Fig.4.4 Controller

They attract each other with opposite poles and repel each other with the same poles. A similar process takes place in a brushed DC motor. The essential difference is in the method of switching the current applied to the wire windings.

In a BLDC motor, this is a mechanical process triggered by a commutator with brushes. In a BLDC motor, it happens electronically with the help of transistor switches.

Controller Specification

Compatible Voltage: 48V / 60V Rated current: 35A
Peak current: 60A Max Power: 2.1Kw
Waterproof Grade: IP64 Regeneration: No
Type: sine wave
Ambient Temperature: 0 to 40 °C
Storage Temperature: -10 to 70 °C Rated voltage: DC 48V/60V
Rated power: 1200W
Rated current: 35A

4.5 DC – DC Converter

The DC-DC converter serves as a crucial interface between a high-voltage battery and low-voltage electrical components, facilitating efficient power distribution while maintaining the main drive system's performance. By delivering a stable and controlled output voltage, it enhances the overall reliability and safety of the electrical system. This conversion process reduces the high-voltage DC supply from the battery to a stable 12V DC output, which is necessary for auxiliary electrical components like lights, switches, and control circuits. The converter continuously regulates the output voltage, ensuring a steady and reliable power supply to connected devices, even amidst battery voltage fluctuations.

Input voltage: 48V
Output voltage: 12V /10Amps
Efficiency: 85 to 90%

4.6 HIGH & LOW BRAKE SYSTEM

Electric two-wheeler controllers incorporate both high and low brake systems to ensure safe and effective braking. The low brake system activates when the brake lever grounds the signal wire, sending a low-level signal that prompts the controller to immediately cut off motor output. Conversely, the high brake

system is triggered by a positive voltage signal supplied during braking.

These dual systems are crucial for rapidly interrupting power to the motor, thereby enhancing rider safety and preventing unintended acceleration while decelerating.

4.7 Miniature Circuit Breaker

A Miniature Circuit Breaker (MCB) is an electrical protection device crucial for safeguarding electrical systems from overload and short circuit conditions. Designed to automatically interrupt current flow upon detection of excessive current, it prevents damage to sensitive electrical components. Within an electric vehicle powertrain, the MCB plays a vital role in protecting the battery, controller, and wiring from potentially damaging fault currents.

V. CONSIDERATIONS FOR EV INTEGRATION

5.1 Mid-Drive Motor Integration at Rear Wheel

- Motor Mounting and Frame Reinforcement
- Drive Chain and Sprocket Configuration
- Power Circuit Integration
- Electronic Speed Control System
- Battery Housing and Weight Distribution

5.2 High Brake & Low Brake System Integration

- Enhanced Braking Mechanism
- Wheel Speed Detection System
- Brake Line Optimization
- Electronic Brake Control Module
- System Validation and Performance Testing

5.3 OVERALL SYSTEM INTEGRATION

- Operational Safety Measures
- Design Optimization and Rider Ergonomics

5.4. SCHEMATIC CONNECTION OF WIRING SET

The Wiring connections are made according to the controller layout and prototype block diagram shown in Fig.5.1

VI. FABRICATION

In the Fabrication stage, the complete two-wheeler is dismantled to fit the motor and battery pack. The Fig. 6.1 shows the dismantled bike. Then the assembled

bike with the motor and battery box is shown in Fig.6.2

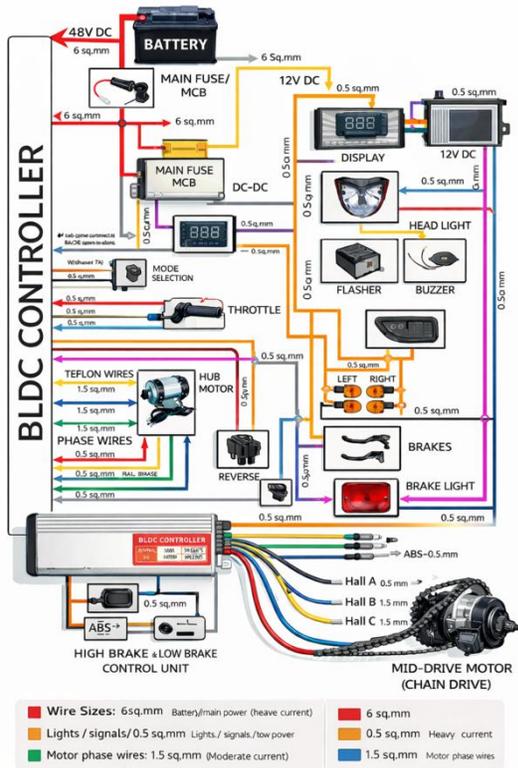


Fig.5.1 Schematic Connection of Wiring Set



Fig.6.1 Dismantled bike



Fig.6.2 Converted bike



Fig.5.2 Working Model of Electric Vehicle

VII. TESTING OF EV TWO-WHEELER

The electric powertrain integration project focuses on converting a conventional two-wheeler into an efficient electric drive system using a mid-drive motor with chain transmission. The vehicle operates purely in electric mode, delivering controlled torque and smooth acceleration through the integrated controller and throttle system. The tested parameters include

7.1. Performance Test: The vehicle achieved a top speed of 35 km/h in a single person load and achieved a top speed of 33 km/h in a two-person load and was consistent in its performance.

7.2. Range and Efficiency Test: Under standard riding conditions, the system achieved an average range of 50 km per full charge. This indicates efficient

power utilization and minimal energy loss during transmission.

7.3. Load Test: During testing, the vehicle exhibited satisfactory stability and motor performance while carrying two passengers. No excessive vibration or overheating was observed throughout the evaluation.

7.4 Charging Test: Using the designated charger, the battery pack reached full charge in approximately four hours.

7.5 Powertrain Reliability Test: During extended trial runs, the mid-drive motor and controller demonstrated reliable performance by operating continuously without any faults. This indicates a robust design and effective system integration.

The electric two-wheeler's powertrain achieved its projected performance, range, and efficiency benchmarks during testing. The mid-drive motor, coupled with the chain drive system, provided consistent torque, resulting in dependable acceleration, seamless functionality, and an improved riding experience throughout the assessment.

VIII. CONCLUSION

The Electric Powertrain Integration project successfully showcased the conversion of a conventional two-wheeler into an electric vehicle. A mid-drive BLDC motor coupled with a chain transmission system effectively transferred torque, maintaining structural integrity and alignment. Optimized mounting, electrical components, controller settings, and battery placement facilitated balanced weight distribution and consistent performance. Even though there were some constraints, such as the space to fit the battery box, the motor alignment, we were able to fit both of these into the engine bay. Testing validated acceptable speed, range, load capacity, and charging capabilities. The chain drive improved torque and control over direct hub systems, enhancing acceleration. Electrical safety measures ensured stable and secure functionality. This project underscores the viability of retrofitting traditional motorcycles with electric powertrains, presenting a cost-effective and eco-conscious transportation option with potential for future development and widespread adoption.

REFERENCE

- [1] Hemant Shete et al., "Design and Analysis of Retrofitted Two-Wheeler Electric Vehicle," IARJSET, April 2024, Vol. 11, Issue 4.
- [2] Mr. Saravanakumar, K., et al "Fabrication of Hybrid Two-Wheeler with ABS System," International Journal of Innovative Research in Technology (IJIRT), Vol. 12, Issue 5, October 2025
- [3] Harshit Kumar et al., "Retrofitting of an IC Engine Vehicle to Electric Vehicle," Materials Research Proceedings, March 2025, Vol. 49, pp. 174–185.
- [4] F. Hoefl, "Internal Combustion Engine to Electric Vehicle Conversion," Transportation Research Interdisciplinary Perspectives, 2021, Volume 10.
- [5] Raghvendra Singh Patel, "Scope of Retrofitting ICE Vehicle into Electric Vehicle," International Journal of Science, Engineering and Technology, 2023, Volume 11:5.
- [6] A. Kumar et al., "Design and Analysis of Retrofitted Two-Wheeler," IARJSET, 2024.
- [7] S. Vitthal et al., "Transformation of Two-Wheeled Electric Vehicle," IJIRT, 2022.
- [8] S. Vitthal et al., "Transformation of Two-Wheeled Electric Vehicle," IJIRT, 2022.
- [9] S. Vitthal et al., "Retrofitting of IC Engine Bike into Geared Electric Vehicle," IJREISS, 2019.
- [10] IEEE APPEEC 2021, "Retrofitting of Conventional Two-Wheelers to Electric Vehicles," November 2021.
- [11] Vyshakh M R et al., "Conventional IC Engine to BLDC Powered Electric Vehicle," IJEET, March–April 2020, Issue 2.
- [12] Vinaya Dodake et al., "Simulation Based Framework Analysis of Electric Vehicle Retrofitting," IJARST, May 2025, Vol. 5, Issue 5.
- [13] L S Prasad et al., "Retro Fitting of IC Engine Scooter into Hybrid Vehicle," IJRSET, April 2023, Vol. 12, Issue 12.
- [14] Asbaan Azeem Shah, "Design & Development of Retrofitting on Bikes," IJRMETS, April 2024, Vol. 6, Issue 4
- [15] Himani Mazumdar, "Layout for Retrofitting an Electric Vehicle," Centre for Sustainable Infrastructure, 2015.

- [16] Alisha J Shaikh et al., “Modifying an IC Two-Wheeler Engine into a Battery-Operated Vehicle,” IJIRT, September 2024, Volume 11 Issue 4.
- [17] <https://bajajverma.com/bm100-2/>
- [18] <https://www.bajajauto.com/customer-service/spares>
- [19] <https://www.sae.org/>