DESIGN & DEVELOPMENT OF COST EFFECTIVE TRANSFORMATION OF A CONVENTIONAL BIKE TO AN E-BIKE

[1]Mr. Ravi kumar K N, [2]Chandan v, [3]Lanchana U, [4]Mahesh K

[1]Asst. Professor, [234]B.E. Student
[1234]Department of Electrical & Electronics Engineering,
[1234]G Madegowda Institute of Technology, Mandya, India

***Abstract*:** The growing demand for electric vehicles is increasing, but commercial E-Bikes are expensive. So, in this project design & development is done to convert a petrol bike into an electric bike using a BLDC motor, Lithium-ion battery, controller and Battery Management System (BMS). The existing bike frame is reused and integrated with a BLDC motor, lithium-ion battery, motor controller, and throttle system to develop a low-cost and eco-friendly alternative. The Battery Management System (BMS) ensures safe battery operation by protecting against overvoltage, undervoltage, and overheating. The converted e-bike helps reduce air and noise pollution, decreases dependence on fossil fuels, and improves energy efficiency. It operates on a 48V, 29Ah lithium-ion battery with a 750W BLDC motor, providing a range of 40–50 km per charge and a charging time of 3–6 hours. This approach demonstrates a practical and affordable solution for sustainable electric mobility.

I. INTRODUCTION

India is undergoing a major transformation in the way people travel, especially in urban and semi-urban regions. With rapid population growth, rising vehicle usage, and expanding cities, the demand for efficient and affordable transportation has increased more than ever before. At the same time, the burden on natural resources is becoming heavier. Petrol and diesel prices continue to rise, and the country remains dependent on imported crude oil. As a result, transportation has become one of the biggest contributors to air pollution, energy consumption, and greenhouse gas emissions. These growing environmental and economic concerns have led to a strong push toward cleaner and more sustainable mobility solutions. One of the most promising ways to achieve this shift is through the adoption of electric vehicles (EVs). Electric mobility is gaining fast popularity in India because it offers a range of benefits compared to conventional petrol or diesel vehicles. EVs run on electricity stored in rechargeable batteries, which eliminates the need for fossil fuels. They produce zero exhaust emissions and significantly reduce noise pollution, making them a cleaner and quieter option for daily commuting. The government of India is also supporting EV adoption through initiatives such as Faster Adoption and Manufacturing of Electric Vehicles (FAME), tax benefits, subsidies, and the development of charging infrastructure. These efforts are encouraging more people to consider electric mobility as a viable alternative.

Among all electric vehicles, electric bikes (E-Bikes) have become especially popular due to their practicality, low running cost, and suitability for Indian road conditions. E-Bikes are compact, lightweight, and easy to handle, making them ideal for travelling in crowded city environments. They can be used for college commuting, office travel, delivery services, and short-distance transportation. As traffic congestion continues to increase, E-Bikes offer an efficient and convenient way to move through narrow streets and busy roads. Their ability to operate without fuel not only reduces monthly travel expenses but also helps in reducing carbon emissions and environmental pollution. The mechanism of an E-Bike is simple yet effective. Instead of an internal combustion engine, the bike is powered by an electric motor. Among different types of electric motors, the Brushless DC (BLDC) motor is widely used because of its high efficiency, low noise, and excellent torque characteristics. BLDC motors offer smooth acceleration and require very little maintenance. Paired with a lithium-ion battery, the system becomes highly efficient and reliable. Lithium-ion batteries are preferred because they are lightweight, long-lasting, and support faster charging compared to older lead-acid batteries. A crucial component in an E-Bike battery system is the Battery Management System (BMS). The BMS ensures the safe operation of the battery by monitoring parameters such as temperature, voltage, current, and state of charge. It protects the battery from issues like overcharging, deep discharge, overheating, and short-circuiting. By balancing the cells and managing power distribution, the BMS extends the life of the battery and ensures safe and efficient performance. This makes E-Bikes a dependable option even for long-term use. E-Bikes are not just a trend; they are becoming a need in modern society. For engineering students and researchers, E-Bike projects provide an excellent hands-on learning opportunity. Working on E-Bikes helps students gain practical experience in areas such as electric motors, drive systems, battery technologies, embedded systems, and mechanical design.

II. LITERATURE REVIEW

[1] Conversion of IC Engine Two-Wheeler into Electric Vehicle: Jadhav and Patil explained the complete method of converting a petrol two-wheeler into an electric vehicle. They replaced the IC engine with an electric motor and used a battery pack for energy storage. Their study showed that the converted electric bike reduced fuel cost, air pollution, and maintenance requirements. This work proved that EV conversion is practical and economical, forming the foundation for the present project. **[2] Sustainable Vehicle**

Retrofitting for Urban Transportation: Kumar and Sharma focused on vehicle retrofitting as a solution for urban transportation problems. They concluded that converting existing vehicles into electric vehicles is more affordable than manufacturing new EVs. Their work highlighted reduced carbon emissions, lower energy consumption, and improved urban air quality. This study supports the concept of sustainable mobility used in this project. **[3] Design and Simulation of Lithium-Ion Battery and BMS:** Patel and Kumar designed and simulated lithium-ion battery systems along with Battery Management Systems (BMS) for e-bikes. Their study showed that BMS protects the battery from overcharging, deep discharge, and overheating. They concluded that proper battery management increases battery life, safety, and performance. This reference supports the use of BMS in the present work. **[4] Analysis of Electric Vehicle Conversion Techniques:** Kumar and Jain analyzed different methods of converting petrol vehicles into electric vehicles. They compared cost, efficiency, and environmental benefits of various techniques. Their results showed that EV conversion is an effective solution to reduce fossil fuel dependency and emissions. This study strengthens the technical justification of the project. **[5] Development of Low-Cost Motor Controller:** Joshi and Mehra developed a low-cost motor controller suitable for electric bike applications. They focused on reducing system cost while maintaining reliable motor control. Their work showed that economical controllers can be designed for practical EV applications. This reference is important for affordable electric bike conversion systems.**[6] Low-Cost Electric Bike Prototype Using Recycled Materials:** The NIT Silchar project demonstrated the development of an electric bike using recycled and reused components. The study emphasized reducing manufacturing cost and material wastage. Their prototype proved that sustainable electric bikes can be built at low cost. This work aligns with the objective of reusing existing petrol bikes in this project. **[7] Factors Affecting Electric Vehicle Adoption:** Chen et al. analyzed social, technical, and economic factors affecting electric vehicle adoption. Their study showed that vehicle cost, charging infrastructure, and environmental awareness strongly influence user acceptance. They concluded that low-cost EV solutions can increase adoption rates. This supports the importance of economical electric bike conversion. **[8] Battery Choice and Management for Electric Vehicles:** Affanni et al. discussed different battery technologies and management methods for electric vehicles. They highlighted the importance of selecting the correct battery type for safety and efficiency. Their work showed that proper battery management improves performance and reliability. This reference supports battery selection in the project.

III. SYSTEM OVERVIEW

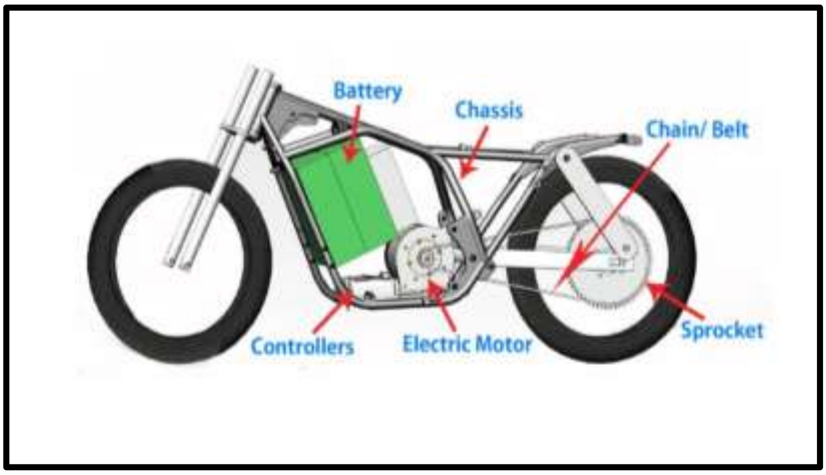

Figure 1. Parts of E-Bike

This diagram represents the working architecture of an electric motorcycle by showing how its major components interact to produce motion. At the centre is the battery, which stores electrical energy and serves as the primary power source. That energy is managed by the controllers, which act as the intelligent regulators, interpreting rider inputs such as throttle or braking and delivering the right amount of power to the electric motor. The motor, positioned centrally for balance, converts this electrical energy into mechanical torque. That torque is transmitted through a chain or belt, which connects to the sprocket mounted on the rear wheel. As the sprocket turns, it drives the wheel and propels the motorcycle forward. All of these parts are mounted on the chassis, the structural backbone that provides strength, stability, and support for both the rider and the mechanical systems. Together, the battery, controllers, motor, transmission system, and chassis form a streamlined loop of energy conversion from stored electricity to controlled power, to mechanical motion that defines the operation of an electric motorcycle.

IV. EXPERIMENTAL SETUP.

1. Hardware Configuration

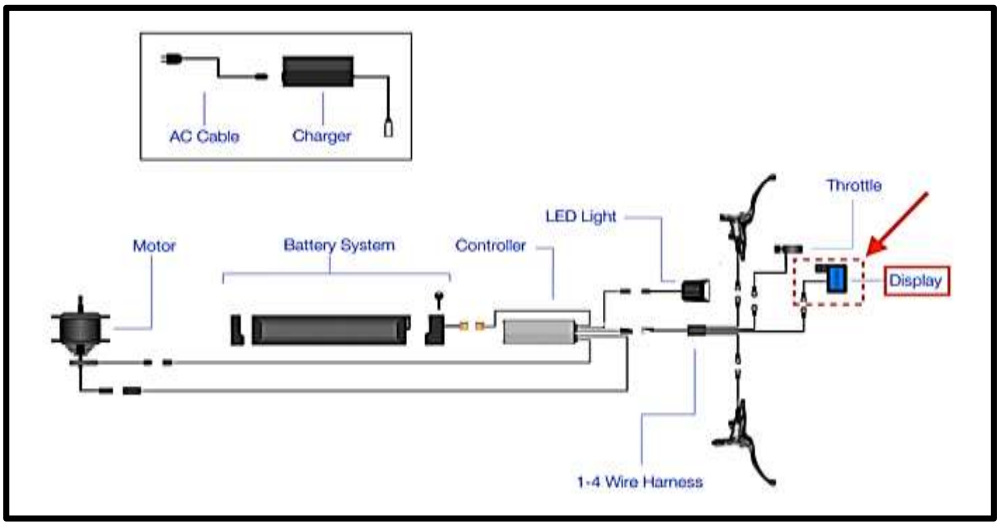

Figure 2. Hardware connection

Building an electric bike is a process of connecting three main systems: the Power Source (Battery), the Brain (Controller), and the Muscle (Motor).

1. The High-Power Connection

This path moves the massive energy needed to spin the wheel. It requires thick wires to prevent overheating.

- Battery to Controller: Connect the battery's Red (+) and Black (-) terminals to the controller's main power inputs.
- Safety Fuse: Always install a high-current fuse or circuit breaker on the Red (+) wire, as close to the battery as possible, to prevent fires if there is a short circuit.
- Controller to Motor: Connect the three thick Phase Wires (usually Yellow, Green, and Blue) from the controller to the motor.

2. The Control Connection: These thinner wires carry signals that tell the controller how to act.

- Throttle: Usually a 3-wire plug consisting of Red (+5V), Black (Ground), and Green/Yellow (Signal). This sends your speed commands to the controller.
- Ignition Wire: A thin red or orange wire on the controller that must be connected to battery power (usually through a key switch) to "wake up" the system.

2. Software Architecture

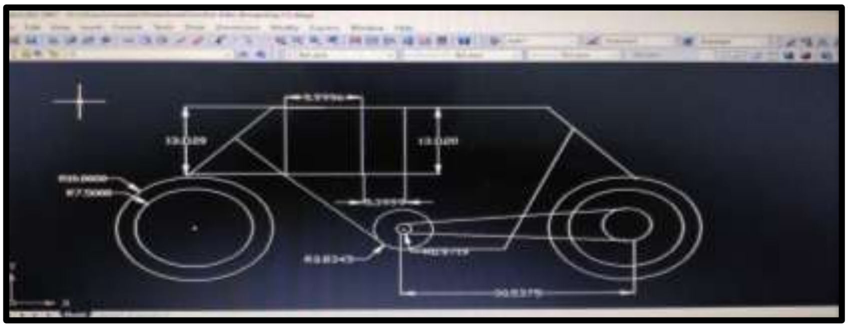

Figure 3. Auto cad 2D design

Computer-Aided Design (CAD) plays a vital role in the conceptualization and development of electric vehicles by allowing engineers to visualize, analyse, and optimize vehicle geometry before fabrication. In this project, AutoCAD 2D is used to design the basic layout of an electric two-wheeler, focusing on dimensional accuracy and component placement. The 2D design illustrates a detailed side view of an electric two-wheeler developed using AutoCAD (EDU version), focusing on accurate geometry and component placement. The design clearly shows the front and rear wheels drawn as concentric circles to represent the tyre and rim, with specified radii to maintain uniformity and proportional balance. The distance between the wheels defines the wheelbase, which is an important factor influencing stability, manoeuvrability, and rider comfort. The frame structure is created using straight and inclined lines, forming a triangular arrangement that enhances structural strength and effectively distributes the load across the vehicle.

The central portion of the frame includes a rectangular area that represents the battery mounting location. Placing the battery at the centre helps in maintaining a low centre of gravity and improves overall vehicle stability. The electric motor is positioned near the rear wheel and is depicted as a circular element, indicating a compact motor layout. A straight line connecting the motor to the rear wheel represents the chain or belt drive mechanism used for power transmission. Proper alignment of the motor and drive system ensures efficient transfer of torque to the rear wheel. The entire drawing is supported with clear linear and radial dimensions, along with annotations, making the design easy to understand, technically accurate, and suitable for use as a conceptual layout for further development and analysis.

V. FLOWCHART FOR ROVER OPERATIONS

The operational process of the IoT-powered Agricultural Rover is created to make certain that there is a smooth flow between the user interface, control modules, and actuator systems. It is a combination of both manual and automated capabilities that allow users to control the navigation of the rovers and the spraying of chemicals with little effort. The following flowcharts will describe the logical mechanism of the navigation control, automatic chemical mixing, and system coordination.

1. **Project flow**

Figure 2. Block diagram of flow of project

The project begins with a detailed requirement analysis to define key performance parameters such as speed, range, load capacity, and budget constraints. **Requirement Analysis:** The initial stage involves defining the technical and functional requirements of the EV bike, such as desired speed (up to 50 km/h), range per charge (approximately 40–60 km), load capacity (up to 150 kg), and cost constraints. This helps in planning component selection and system design effectively. **Component Selection and Procurement:** Based on the requirements: A 48V, 750W BLDC is selected for rear-wheel drive. A 48V, 20Ah lithium-ion battery is chosen to ensure sufficient range and power. Other key components include a motor controller, BMS, motor controller LED lighting, charger, and fuses/connectors. An old scooter chassis is sourced to reduce structural fabrication costs and support reusability. **Mechanical Modification and Setup:** The scooter frame is inspected and modified to accommodate the battery, motor controller, and other electrical components. Custom mounting brackets and enclosures are fabricated using metal or ABS plastic to ensure proper protection and fitment. **Motor and Electrical System Installation:** The BLDC motor is mounted on the rear wheel hub, eliminating the need for chain drive. The motor controller is installed on the frame and wired to the throttle and motor. The lithium-ion battery is placed inside a custom battery box with a secured locking system and connected to the BMS for safety. **Wiring and Integration:** All electrical components are connected using high-gauge wires with proper connectors. A fuse and power switch are included for protection. Powering LED headlight, tail light, and indicators. Wiring is neatly routed and insulated for protection from moisture and heat. **Installation of Lighting and Safety Systems:** A complete 12V lighting system is installed, including LED headlight and tail light, Left and right turn indicators, Brake light (optional). **Testing and Troubleshooting:** The assembled system is tested in stages. Initial bench testing of individual components, Continuity and voltage level checks, test rides to evaluate motor response, battery drain, braking, and load handling. Any electrical or mechanical faults are identified and corrected to ensure safe and efficient functioning.

VI. RESULTS AND DISCUSSION

Figure 5. Side view of E-Bike

Successfully developed a fully working electric bike by using an old two-wheeler frame and adding electric components like a BLDC motor and lithium-ion battery. The bike runs smoothly and be able to carry one or two persons safely. It reaches range of 40 to 60 km on a full charge. The battery will take about 5 hours to charge completely. Safety systems such as a Battery Management System and MCB protection will be used to prevent damage or accidents.

VII. CONCLUSION

This project proves that converting an existing petrol bike into an electric bike is a practical, economical, and eco-friendly solution. +By reusing the existing bike frame and integrating essential electric components, the overall conversion cost is significantly reduced. The use of a BMS ensures safe and reliable battery operation. The converted e-bike helps reduce air and noise pollution, decreases dependency on fossil fuels, and promotes energy-efficient transportation. Hence, this project supports the adoption of sustainable electric mobility with minimal modification to existing vehicles.

VIII. REFERENCES

[1] A. R. Jadhav and S. W. Patil, "Conversion of IC engine two-wheeler into electric vehicle," International Research Journal of Engineering and Technology (IRJET), vol. 6, no. 3, pp. 1349 1353, Mar. 2019.
[2] N. R. Kumar and R. Sharma, "Sustainable vehicle retrofitting for urban transportation," Journal of Green Engineering, vol. 10, no. 4, pp. 202–210, Apr. 2020.
[3] S. Patel and V. Kumar, "Design and simulation of lithium-ion battery and BMS for E bikes," International Journal of Electrical and Electronics Engineering Research, vol. 11, no. 1, pp. 101–110, Jan. 2021.
[4] A. Kumar, S. Jain, "Analysis of electric vehicle conversion techniques for sustainable transportation," Energy Reports, vol. 7, pp. 2150–2157, 2021.
[5] K. Joshi, A. Mehra, "Development of low-cost motor controller for electric bike," International Conference on Power, Control and Embedded Systems (ICPCES), IEEE, 2021. [6] NIT Silchar, "Low-Cost Electric Bike Prototype Using Recycled Materials," Student Innovation Project Report, Department of Mechanical Engineering, 2022.
[7] Chen CF, Rubens GZD, Noel L, Kester J, Sovacool BK. Assessing the sociodemographic, technical, economic and behavioral factors of nordic electric vehicle adoption and the influence of vehicle-to-grid preferences. Renew Sustain Energy Rev April, 2022;121:1– 13. 109692.
[8] Affanni, A. Bellini, G. Franceschini, P. Guglielmi, and C. Tassoni, "Battery choice and management for new-generation electric vehicles," IEEE Trans. Ind. Electron., vol. 52, no. 5, pp. 1343–1349, 2023.