iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 Issue: V Month of publication: May 2025

DOI: https://doi.org/10.22214/ijraset.2025.70451

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue V May 2025- Available at www.ijraset.com

Study of Existing Electrical Vehicle and its Modifications

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Abstract: Electric vehicles have become the heart of transportation in today's world that is moving toward greener alternatives. EVs-fuel-efficient, cleaner, quieter compared to traditional vehicles, require less maintenance due to fewer moving parts, and no engine oil, transmission fluid or coolant, in addition to reducing air pollution. The project contributes directly to the enhancement of an existing departmental electric two-wheeler through battery improvements and smart monitoring features. Replacing old lead-acid battery with new battery system while setting up a user-friendly off board manually charging system, the ultimate goal of making the vehicle more reliable and efficient for daily uses will be attained. Moreover, adding a digital display for live battery and speed monitoring will provide ease of use and maintenance. This is a project, but a meaningful step toward smarter, sustainable electric mobility as well.

I. INTRODUCTION

Electric vehicles emerge in recent times as the way forward for sustainable and contemporary transport during rapid technology advancements and increasing awareness about the environment. They control greenhouse emissions, limit the dependence on fossil fuel resources, and thus create a cleaner urban mobility system. With industries around the world making the transition to green alternatives, improving the electric vehicle system becomes important for enhancement of user performance, reliability, and satisfaction.

This research targets the performance efficiency of an entirely electric two-wheeler that is to be upgraded by means of battery and intelligent information monitoring. The project relates to replacing existing power sources with new 12V, 12Ah lead-acid batteries connected in series since this is what the motor and controller require as voltage specification. A manual off-board charging system using a 12V, 10A adapter has been implanted for safe and efficient battery recharge. All power sources present at the site under consideration are to be replaced with 12V, 12Ah lead-acid batteries in series, as needed by the motor and controller under this voltage specification. A manually operated off-board charging system is developed using a 12V, 10A adapter, ensuring a safe and effective battery recharge. It features multimedia components like a digital speedometer and real-time battery status display system to improve user interaction and simplify maintenance of the new vehicle. Modifications to the wirings and power distribution are designed to make the system more reliable. This project showcases how practical EV upgrades can significantly contribute toward a brighter and greener sustainable future in achieving mobility environments that are Environmentally friendly and economically intelligent.

II. LITERATURE SURVEY

Since the technology related to electric vehicles (EVs) is evolving fast, researchers all around the globe are trying to come up with ways for better performance and efficiency and long-term sustainability. Kaduskar et al. [1] tried this with induction hub motors used as an outer rotor, with torque and thermal performance analyzed through ANSYS simulations. Their work showed promising improvements that are especially useful for compact motor setups. Although this study uses a 750W BLDC motor, the methodology and results from Kaduskar et al. offer valuable insights for enhancing small EV motor performance through simulation and design optimization.

In another study in a similar arena, Kadam et al. [2] analyzed how vehicle design principles such as components and energy management affect energy efficiency and hence battery life. These strategies resonate well with our project, which is meant to implement intelligent monitoring and preserve lead-acid battery longevity.. Meanwhile, Cunha et al. [3] proposed a new power conversion solution with a bridgeless boost half-bridge DC-DC converter for increased efficiency through reduced power loss. Our current system employs a simple 12V 10A off-board charger, so their work gives a good indication of where advancement in charging technology should go.

Thermal management is also crucial in determining battery performance. Making way for work done by Amir et al. [4] to control temperature of the battery by use of phase change materials. Although such thermal regulation is not considered in our present design, the findings point toward further enhancements in safety and battery life, particularly in hot climates. In a more practical manner, Newe et al. [5] analyzed real-world charging patterns and vehicle-specific load profiles. Their findings help design smarter and more efficient charging strategies, something which we intend to include in our digital instrumentation system.
Away in the far distant, Sachuthananthan et al. [6] pointed out both opportunities and hurdles that EV and technologies face today. Their work elucidates some reasoning as to why cheap, simple, and sturdy EV solutions are such an essential requirement for the developing countries such as India. Acharige et al. [7] took this further by surveying the charging technologies, charging standards, and the system architectures of off-board charging, which are certainly among the considerations one needs to take into account when scaling our off-board charging setup in a safe manner. Building on that, Yuan et al. [8] explored bidirectional on-board chargers that could one day allow EVs to return energy to the grid. While that's beyond the current scope, it's certainly something to consider for future versions of our design.
Frieske et al. [9] studied trends in EV design, emphasizing the shift toward lighter and more modular vehicles with digital control systems-a shift that exactly parallels the digital instrumentation of our project. Valsera-Naranjo et al. [10] talked about the stress potential of EVs on power grids, thus strongly arguing in favor of efficient, grid-friendly charging infrastructure as we are developing.
Price is always a serious issue to reckon with. Finding the economics between the conventional vehicles and the plug-in EV set a precedent for Rehman and Morsi [11]. Their comparison yields a useful framework through which it can be ascertained whether a reasonable value can be generated by our design for a price-sensitive market. Finally, Ghaderi et al. [12] went into depth using advanced control methods like direct torque control to improve motor performance. While at the moment we are using conventional BLDC control, such innovations would really give a future iteration of the vehicle a performance boost.

III. METHODOLOGY

The completion of this project has analyzed the whole system thoroughly regarding the most critical factors that the entire system undergoes. Each component was analyzed according to its respective functions and specifications and its position concerning the entire design. Knowing this will guide the proper choice and integration of the right parts during application. Testing and evaluation were also included in the methodologies to ensure that the assembled system attains optimum performance.

A. EV Block Diagram

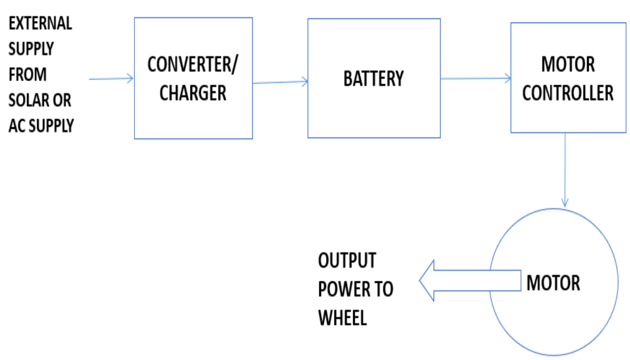

Fig.1. EV Block Diagram

This source of supply includes both solar and grid electricity. That initial electricity supply example will charge the battery of the electric vehicle. Supply might in the form of electricity from the grid (AC supply) or energy harvested from the sunlight using solar panels.
This converter acts as a bridge between incoming energy from external sources and the charging of a high voltage battery. The charger-rectifies AC supply into DC.
Besides it manages charging, safety charging, and controlled voltage and current levels.

- Battery: This energy storage unit of the electric vehicle holds the electrical energy that is going to drive the motor. Batteries used in EVs are usually of high capacity and designed for deep discharge and recharge cycles.
- Motor Controller: this is an electronic device that acts for the relay between the battery and the motor. It takes the DC power from the battery and regulates it, so as to define the voltage and current delivered to the motor.
- The relay has an input control for interpreting the desired speed and torque and adjusts the power to the motor according to that derived from the accelerator and brake pedals. This is the heart of the electric powertrain; converts electrical energy through the motor controller into mechanical energy to propel the vehicle. With electric motors, torque is provided immediately, resulting in a smooth acceleration that operates more efficiently.
- Power to wheels: The motor creates mechanical energy that travels to the wheels to rotate and move the vehicle. This is mostly dependent on the vehicle layout that either utilizes a transmission system or a direct drive. In essence, the diagram showcases how energy is captured from an external source, stored in the battery, controlled by the controller, and used by the motor to finally propel the vehicle. It identifies the main components of the electric powertrain and the interlinkages involved in the delivery of power to wheels.

1) Battery Bank

Fig.2. Battery Bank

The power source of the electric vehicle comprises four 12V, 12Ah sealed lead-acid (SLA) batteries connected in series to form a 48V system. This configuration provides a total energy capacity of 576 watt-hours (Wh), calculated by multiplying the voltage (48V) by the amp-hour rating (12Ah). Lead-acid batteries are relatively cheap and available, and additionally, their performance in handling high current loads is optimal and very robust, making them elite in application in budget EVs. However, these batteries have other serious limitations, like less energy density, high weight, and poor performance in deep discharge cycles. Hence, battery management should be efficient to ensure longevity and consistent performance.

2) Brushless DC (BLDC) Motor

Fig.3. Brushless DC (BLDC) Motor

The propulsion system is built around a 750-watt brushless DC (BLDC) motor, which is m uch more efficient, reliable and reduces maintenance compared with the conventional brushed motors. Due to its brushless design, there are eliminated mechanical wear components of operation, giving it a quieter motor and a longer life. The 750 watts power rating fits light-duty electric vehicles comfortably while generating sufficient torque as well as acceleration for urban commuting. Energy conversion is smoothened by the motor working with the 48V battery system.

3) Motor Controller

Fig.4.Motor Controller

Motor controller from Wonderful Company is operated at an input voltage of 48V DC with maximum power output possible of 900 watts. The motor controller allows the regulation of the current and voltage supply to the BLDC motor, effectively controlling speed, torque, and directional movement in response to the throttle input. The motor controller is rated at 900W, leaving a good margin above the 750W required by the motor so the controller can manage short bursts of peak power delivery without overheating. Other technical information like the control algorithm and protection features are unavailable, but the controller plays a pivotal role in making the motor respond in a very effective way.

4) Digital Speedometer

Fig.5.Digital Speedometer

The Kainotec LED Digital Speedometer provides the rider with essential information that includes current speed and total distance traveled (odometer reading). The size is 18 × 12 × 8 cm, and the weight is around 700 g. Besides speed and distance tracking, it has indications for high beam and both left and right turn signals, which considerably increase safety and visibility on the road for the rider. Its compact and lightweight structure makes it ideally suited for electrictwo-wheelerdashboards

5) Battery Charger

Fig.6.Battery Charger

The 12V DC, 10 Amp Battery Charger is used for charging, with each 12V battery being charged independently. The significance of this procedure is because the batteries are connected in series during operation; charging the batteries separately would ensure voltage balancing and prolong battery lifespan. Provided that it fits the current rating of the battery, the 10A output makes charging relatively fast and safe as well. As in lead-acid batteries, the charging must be free from overcharging, sulfation, and gradual decay in capacity.

B. Electric Vehicle Circuit Diagram

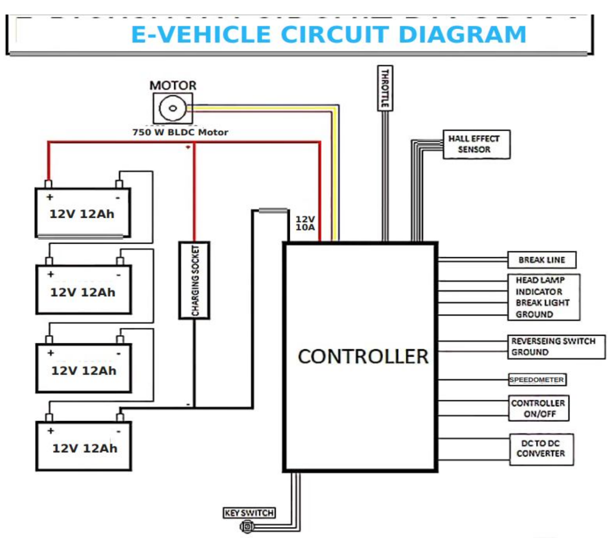

Fig.7.Electric Vehicle Circuit Diagram

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The circuit diagram outlines a fundamental electric two-wheeler. It uses a 750W BLDC motor powered by a four-cell series pack of 12V, 12Ah batteries, amounting to 48V. Motor operation is tailored and controlled by a throttle and feedback from a Hall-effect sensor, as well as managed in terms of other accessories like the headlights, indicators, and a brake light with a DC-DC converter that steps down voltage. It comes complete with an off-board connector for charging the batteries, a mechanism for switching on and off, and safety devices such as an ignition key switch. Apart from connecting the controller to the motor with three-phased wires, the entire wiring is color-coded while low-voltage cables serve power for other auxiliary functions. The system thus provides complete and effective control for the motor as well as reliable power distribution and actual operational integration of the complete vehicle electronics.

C. Battery Manual System

Batteries will get connected in series such that the positive terminal of one battery gets connected to the negative terminal of another. Then, all such series-coupled batteries add voltages. Current or current capacity, however, shall remain the same (assuming that the batteries are identical) at output.

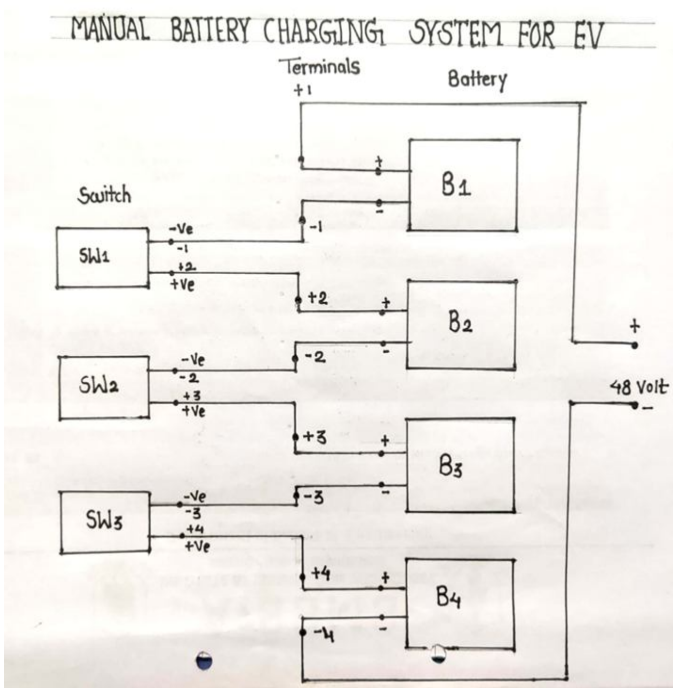

Fig.8.Manual Battery Charging System For EV

A. Parallel Connections

It connects positive terminals together and negative terminals together; thus their voltages remain the same (assuming that these batteries are identical) while their current capacities add up.

B. Switches Analysis

The switches would make a switch for connecting the batteries.
It considers all the possible switch wise configurations:

- Sw1 closed will connect B1 to the output in someconfiguration.
- Sw2 closed will connect B2 in some configuration to the output.
- Sw3 closed will connect B3 and B4 in some configuration to the output.
- The configurations and equations are as follows:

Knowing the exact internal wiring that is controlled by the switches (which is not entirely clear from the diagram), we could potentially describe the various situations for output voltage and current as follows:

- If a single switch is closed (assumed to connect a single battery to the terminals):

1) *If Sw1 is closed*
   - V_{out}= voltage at terminals= Voltage of B1 (V_{B1})
   - I_{max}= maximum current= Current capacity of B1 $_{(B1)}$

2) *If Sw2 is closed*
   - $V_{out} = V_{B2}$
   - $I_{max}= I_{B2}$
   - If Sw3 is closed (B3 and B4 are in series):
   - $V_{out}= V_{B3} + V_{B4}$
   - I_{max}= Current capacity of B3 (assuming $I_{B3}=I_{B4}$)
   - If Sw3 is closed (B3 and B4 are in parallel):
   - $V_{out} = V_{B3}$ (assuming $V_{B3} = V_{B4}$)
   - $I_{max}= I_{B3} + I_{B4}$
   - If a number of switches were closed, the situation would become increasingly complicated:
   - Sw1 and Sw2 Closed (and assuming B1 and B2 are connected in series):
   - $V_{out}= V_{B1} + V_{B2}$
   - I{max}= Current capacity of B1 (assuming $I_{B1}= I_{B2}$)
   - Sw1 and Sw2 Closed (and assuming B1 and B2 are connected in parallel): $V_{out}= V_{B1}$ (assuming $_{B1} = V_{B2}$)
   - $I_{max}= I_{B1} + I_{B2}$
   - Sw1 and Sw3 Closed (Here, the configuration will depend on how the switches are tied to B1, B3, and B4).
   - Sw2 and Sw3 Closed (The configuration depends on how the switches are linked to B2, B3, and B4).

IV. RESULT

This vehicle is electric and has two wheels. The upgrades mostly focus on the various aspects of battery, motor control, charging, and digital instrumentation. The aptness of this project is to confer high performance, reliability, and user-friendliness on the vehicle by infusing newer technologies while still keeping it economical and efficient in design. The battery upgrade involves replacing the lead-acid battery arrangement with a logically structured and balanced 48V battery system in which four 12V, 12Ah sealed lead-acid (SLA) batteries withstand the series connection to form a system voltage of 48V. The energy capacity of the system is calculated as Energy (Watt-hour)= Voltage (Volt) × Capacity (Ampere-hour). In this way, the whole energy capacity comes out to be 576Wh, which is energetically sufficient for urban commuting and also ensures that the motor receives backing from the required voltage for its optimal working. For improving the reliability and duration of service of the battery system, an off-board manual charging setup is introduced with a 12V, 10A DC adapter. Charging each battery separately will keep the step voltage of every battery balanced, thereby preventing overcharging, sulfation, or uneven wear that are common problems in a series-connected lead-acid battery system. This will increase the life span of the batteries and make sure of a steady power feed to the motor and other appliances. The main attraction within the enhanced propulsion system is a 750W brushless DC motor.

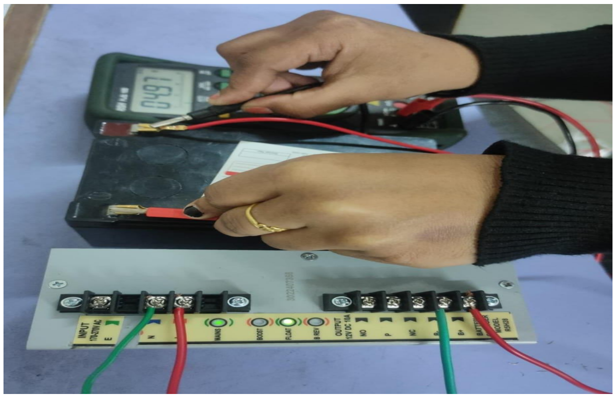

Fig.9. Battery Testing

The motor gets its energy from a 48V battery pack, while the motor controller of 48V and 900W rating manufactured by the Wonderful Company manages its operation. This motor controller offers finely tuned and precise control over the delivery of power, manipulating voltage and current flow according to a throttle input signal. Some of the key parameters of the motor it regulates are speed, torque, and the direction of rotation, all of which allow it to furnish an intuitive and stable ride with the 900-watt rating of the controller providing a safety margin above the 750-watt requirement of the motor to accommodate the peak power demands during acceleration climbing without stressing the system.

The Kainotec LED digital speedometer is housed inside the dashboard for maximizing the awareness and safety of the rider during operations. It has a rather tiny interface that shows the running speed of the vehicle along with recording the distance traveled and also acts as an indicator for high beam and turn signal. With a weight of approximately 700 g and absolute dimensions of 18 cm × 12 cm × 8 cm, this product is just great to mount on electric two-wheelers and lends a modern appeal to it whilst assisting the situational awareness of its user during operation. The electrical circuit for the uprated vehicle has been modified to a very large extent. An updated electrical diagram has been prepared to indicate the architecture along with interconnections between vital components such as motor, controller, throttle with Hall-effect sensor, and accessory devices. The vehicle is equipped with a DC-DC converter to step down the 48V supply to low voltage for components such as headlights, indicators, and brake lights. Additionally, an ignition key switch and an off-board charging connector promoting safety, color-coding of wires for easy usability, and maintenance are also introduced. Electrical systems and wiring of the electric two-wheeler were improved considerably for performance, ease of use, and maintenance. The prime element of the upgrading was the introduction of a 48V power system made of four 12V, 12Ah sealed lead-acid batteries connected in series to provide an output voltage of 48V and a total energy capacity of 576 watt-hours (Wh), wherein the energy capacity is the multiplication of total voltage and ampere-hours (48V × 12Ah). This guarantees adequate power to the 750W BLDC motor to impart extended range and consistent performance with varying loads. A 48V, 900W rating motor controller was fitted to control the power delivery to the motor. It is rated higher than the motor to offer protection against overload and to regulate downstream voltage and current so as to respond to rider input from the throttle and Hall-effect sensors.

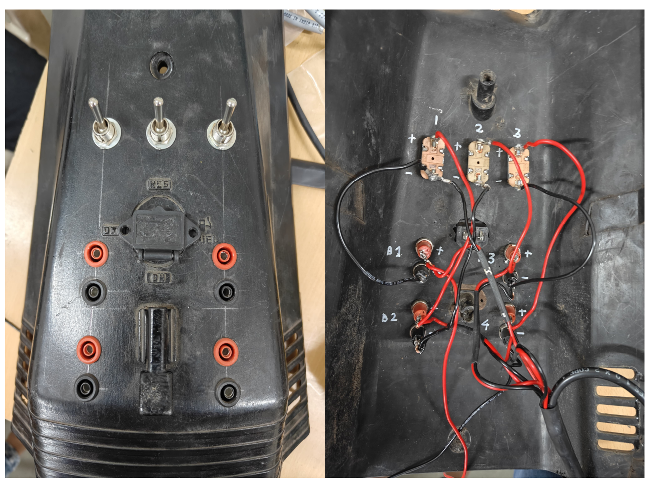

Fig.10.Battery Manual System

The system also includes a digital speedometer and driver-side lighting equipment comprising headlights, indicators, and brake lights. These are powered by a DC-DC converter, which steps down the main 48V supply to 12V to completely isolate the sensitive auxiliary systems from the high-power motor circuit, thus ensuring their operation. The salient features of the modified system involve a smart manual switching mechanism comprising three switches (Sw1, Sw2, Sw3), which permits batteries to be selectively connected, either individually or in combination, to the output terminals. So depending upon the switch position, user can choose from any of the battery configurations to operate the batteries either in series for higher voltage or in parallel for higher current capacity. For example, closing switch Sw3 could connect batteries B3 and B4 either in series for 24V or in parallel for more amp-hour capacity, depending on internal wiring. This manual switch provides a way for maintenance, partial battery usage, or testing without the need to dismantle the battery pack.

Charging of batteries is carried out through a 12V, 10A off-board charger by connecting one battery at a time via the dedicated charging port so that batteries are not charged in an imbalanced manner. This ensures that a great degree of credibility is given for the health maintenance of lead-acid batteries. The deterrence against unintentional motor activation is infused via the ignition key switch, whereas red and black colors denote power wiring, making diagnostics and maintenance even more straightforward. In sum, these modifications bring forth much improvement to electrical performance, safety, and serviceability of the vehicle. In other words, a logical approach to modernizing electric vehicle.

Fig.11.Electric Vehicle Model

The circuit uses a flexible battery switching network consisting of four batteries B1, B2, B3, and B4, and three switches Sw1, Sw2, and Sw3, so that different mixtures of series and parallel configurations of these batteries can be made to yield different voltages and currents at the output terminals. This is where basic knowledge of battery combinations is applied: in series, voltage increases but current remains the same; in parallel, current capacity increases while voltage remains constant (assuming identical batteries). When considered one by one, the closing of switches connects certain batteries at the output, either singly or in combination (with Sw3, batteries B3 and B4 might be configured in series or in parallel). When more than one switch is closed at once, further combinations arise, such as placing batteries B1 and B2 in either series or parallel, or putting either B1 or B2 in combination with the B3-B4 sub-circuit. As for the output voltage and current under such multiple switch conditions, these will very much depend on how the switching network is wired internally. In the absence of a complete schematic of this switch network, only general assumptions can be made regarding the working of the circuit. Thus, while the very design attempts to give versatility and flexibility to various output properties by practically allowing manual switching, conducting an exact electrical analysis of all configurations calls for a complete and clear circuit diagram showing the exact interconnections and, thus, the electrical parameters that result therefrom.

V. CONCLUSION

The project seeks to improve any given realization of an EV within the aspect of performance and reliability by addressing some of the most important issues: Battery cycle life degradation, aging, and temperature sensitivity. Basically, these are problems that reduce the power the batteries can give and, in turn, the range of the vehicle by time, hence necessitating newer systems of energy. The prime recommendation was to discard the existing degradable lead-acid batteries and activate those offering a superior energy density with a longer life and a better thermal resistance. An efficient charging system would have been another recommendation to keep battery health criteria above and allow alterations in supply wiring and power distribution for long life.

A digital display would appear to show real-time information on battery charge, speed, and system status, thereby enhancing the user experience and operating efficiency. Reduction in weight would have been another consideration for range enhancement using lightweight materials. Hence, these modifications facilitate a more sustainable and reliable EV model focusing somewhat more on battery life, charging efficiency, and the interface from a user's point of view. This project is one of the practical ways to attain sustainable electric vehicle technology and hence serves as a great platform for further EV activities within the department.

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