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Design and Development of Electric Two Wheeler Conversion Kit

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Abstract: *The design and development of an electric two-wheeler conversion kit aim to provide a cost- effective and eco-friendly alternative to conventional petrol-powered vehicles. This kit is designed to replace the internal combustion engine with an electric motor, battery pack, and controller system with minimum changes to the existing vehicle. This not only reduces fuel consumption and harmful emissions but also gives a sustainable upgrade to old vehicles and prolongs their life. The study focuses on component selection, system integration, and performance evaluation for reliable operation, energy efficiency, and user convenience. This conversion kit provides a practical solution for the promotion of green mobility and reduced dependence on fossil fuels in urban transportation. "Nowadays, pollution is a major issue in the universe. The main goal of this project is to make a simple and affordable electric bike with two wheels to reduce air pollution and save money on fuel. So, it does not require petrol and it makes less noise. It is designed for easy use, with parts such as a battery, motor, and controller to control the speed at which the bike travels. Bike charging can be used for daily trips or quieter transportation. An electric bike is one of the best options for environmentally friendly transportation. This has made riding easier and quicker, especially uphill or for long distances.*

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I. Introduction:

Designing and developing an electric two-wheeler conversion kit is an innovative approach to facilitating sustainable transportation by transforming conventional petrol-powered vehicles into eco-friendly electric ones. As fuel prices increase, environmental concerns rise, and emission norms become stricter, electric mobility demand shoots up. It is an economical and practical way for already-existing two- wheeler owners to switch over to electric mobility without having to make investments in brand new vehicles. A conventional internal combustion engine is replaced with an electric motor, a battery pack, controller, and prerequisite wiring without compromising safety, reliability, and performance. This decreases carbon emissions, besides offering economic advantages like reduced operating costs and improved energy efficiency. Such a kit would need designing, optimization, and compatibility with various models of two- wheelers to finally help clean up the mode of transportation and assist the world's efforts toward sustainable development. Development of electric two-wheeler conversion kits is one practical and effective solution that can help accelerate the transition toward green mobility. Instead of manufacturing new electric vehicles, these kits can retrofit the electric propulsion systems into existing petrol-powered motorcycles and scooters. Consequently, this not only reduces the cost burden on users but also minimizes environmental impact by avoiding the need to scrap old vehicles.

II. Literature Survey

1. VINAYAK MULIK (2022)

Conventional vehicle loses their efficiency after a long duration. Retrofitting gasoline powered vehicles into an electric vehicle is a cost-effective and beneficial process. During the retrofitting, the powertrain, electrical parts and vehicle parts (swing arm, bush, and bearing) are required to modify and the remaining subsystems like suspension, steering, and braking will be the same transmission.

2. Dr. A. D. DIWATE (2020)

Describes a practical student project converting a conventional scooter into an electric two-wheeler: component selection, basic sizing calculations, fabrication details and performance observations. Concludes retrofit is feasible and reduces emissions but highlights battery and controller design as critical.

3. Mr. Akshay Sasane (2024)

Presents design and fabrication of a hybrid retrofit kit (internal combustion electrical assist) for two-wheelers. Covers component selection, mechanical integration and experimental testing; shows improved fuel efficiency.

4. Ms. Pooja A Trishulwar

This work is intended to design a mountable electric vehicle conversion kit based on existing Motorcycle Components. The conversion kit is checked for desirable power output & structural stability by performing calculations finite element analysis. The use of existing vehicles components for electric vehicles could be the best solution.

5. Dr. Akash Anil Vaidya

This study explores the feasibility of converting conventional two-wheelers with internal combustion engines (ICEs) into electric cars. Preliminary testing shows that converted two-wheelers can perform similarly to electric models, increase energy efficiency, and reduce operating costs. Despite initial costs and technical reliability issues, overall user acceptability is good due to economic and environmental savings.

III. Methodology

I should focus on providing two concise paragraphs without including citations. I'll aim to describe key parts of the methodology, including requirements, selection, modeling, CAD, FEA, electrical integration, and testing, all while keeping it clear and organized. Safety, prototyping, iterations, and documentation will also come into play, but I should avoid unnecessary details. Keeping things short and sweet, no more than 4 to 6 sentences total for both paragraphs. Let's get to it! We followed a structured, requirements-driven methodology: define target vehicle class, performance goals (range, top speed, grade ability), packaging constraints, and regulatory/safety needs. Size the powertrain using duty-cycle analysis to determine motor power/torque, gear ratio, controller current, and battery capacity, then validate with a simple longitudinal vehicle model. Develop the mechanical kit (mounts, sprocket/gear interface, and chain/belt selection) in CAD, run FEA for brackets and fasteners, and ensure maintainability and OEM frame integrity. In parallel, design the electrical architecture (battery, BMS, fuse/relay, contactor, DC-DC converter, wiring harness, connectors), create schematics and harness drawings, and define isolation, interlocks, and emergency cut-off.

IV. Working Principle

4.1 16 INCH HUB MOTOR:

The 16-inch hub motor finds broad application in small electric vehicles, such as bikes, scooters, and wheelchairs, by integrating into the hub directly for a compact, low-maintenance, and efficient performance.

Fig No: 4.1 16 INCH HUB MOTOR

The "16-inch" here refers to wheel diameter, not the size of the motor, and most modern versions employ BLDC technology for a smoother, longer-lasting operation. Offered in power from 250W to 1000W and voltages from 24V to 48V, lighter motors are best for city commuting, while higher outputs handle heavier loads or faster

speeds. Hub motors come in geared types for higher torque in hills and gearless direct-drive types for simplicity. They are typically paired with controllers, throttles, PAS sensors, and brake
levers that offer cut-off functions to manage speed, braking, and overall operation..

4.2 BATTERY (60V-32Ah):

A 60V 32Ah lead-acid battery is a typical source to power small to medium EVs, such as e-bikes, scooters, and rickshaws, storing around 1.8 kWh of energy that supplies DC power to the motor controller, regulating electricity to the motor for vehicle movement.

Fig No: 4.2 BATTERY

It works by chemical action: lead dioxide, sponge lead, and sulfuric acid generate electricity on discharging and the process reverses on charging. Charging takes 8-10 hours at 69-72V and gives a range of 50-70 km according to the load/conditions. Being very heavy and short-lived (1.5 to 2 years), the

lead-acid battery is still used in low-cost EVs because it is inexpensive, reliable, and easy to service.

4.3 Wired Controller 60V/32Ah:

The Wired Controller 60V/32A plays a key role in the electrical drive systems of electric vehicles such as e-bikes, scooters, rickshaws, and other light electric mobility devices.

Fig No: 4.3 Wired Controller 60V/32Ah

It is the brain of the electric drive system: it regulates power delivery from the 60V battery to the motor and ensures that the motor runs efficiently, smoothly, and safely under diverse conditions. The controller can handle up to 32 amps of current, meaning it is capable of supplying up to 1440 watts of power (60V × 32A = 1440W), thus defining how powerful the motor can be while using this controller.

4.4 Waterproof Throttle and Three Speed Switch:

The Waterproof Throttle with a three- speed switch is a multitasking device for EVs, such as e-bikes and scooters, in which throttle control, forward/reverse switching, and adjustable speed modes are combined. It outputs variable signals to the controller via a Hall Effect sensor to regulate the speed of the vehicle. The reverse switch helps in maneuvering through congested areas, and the three-speed switch offers low, medium, or high limits for various conditions.

Fig No: 4.4 Waterproof Throttle

Generally, it has 8 wires-throttle, speed, and reverse-enclosed in IP54+ housing for durability, thus simplifying installations while improving safety and reliability for a better user experience.

4.5 MCB 63A DC Switch:
The 63A DC MCB is one of the most crucial circuit breakers that work on the widely in-service basis of DC.

Fig No: 4.5 MCB 63A DC Switch

It provides reliable protection to various circuits operating at or below 63 amperes of current by automatically disconnecting the power supply on the occurrence of overcurrent or a short circuit. While AC MCBs are more common in household and industrial distribution boards, their DC counterparts are used where direct current operations are employed, such as in battery storage installations, EV charging systems, DC motor drives, and telecommunication installations. For protection equipment, DC systems, because of the unidirectional nature of the current and difficulty in breaking the DC arc as compared to AC, present special challenges.

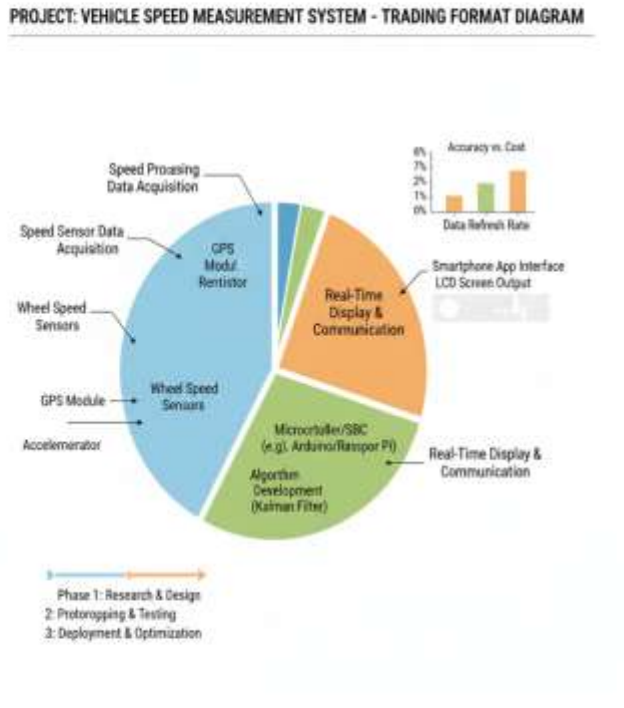
4.6 DC to DC Converter 10A:
In EVs, a 10A DC-DC converter plays an important role in stepping down high- voltage battery power of 48-72V to 12V for auxiliary systems like lights, horns, and dashboard electronics.

Fig No: 4.6 DC To DC Converter 10A

Delivering up to 120W, it ensures stable output despite battery fluctuations and replaces the alternator to keep the 12V battery charged. Compact and efficient up to 95%, these converters are rugged, waterproof IP65/IP67, and include protections against short-circuit, over/under-voltage, thermal overload, and reverse polarity. They provide reliable power for small and mid-sized EVs, ensuring safe, uninterrupted operation.

V. Vehical Testing

5.1 SPEED MEASUREMENT:



1. Speed Conversions
(a) km/h to m/s
v=68×518=18.89 m/s
(b) km/h to mph
v=68×0.621=42.25 mph

2. Distance Calculations
(a) Distance in 10 minutes
t=10/60=1/6 hourt
d=68×1/6=11.33 km

(b) Distance in 30 minutes

t=0.5 hourt = 0.5
d=68×0.5=34

3. Time Calculations
(a) Time to travel 20 km
t=20/68=0.294 hourt
=17.6 minutes
(b) Time to travel 100 m
t=100/18.89
=5.29 seconds

5.2 HUBMOTOR TEMPERATURE ANALYSIS

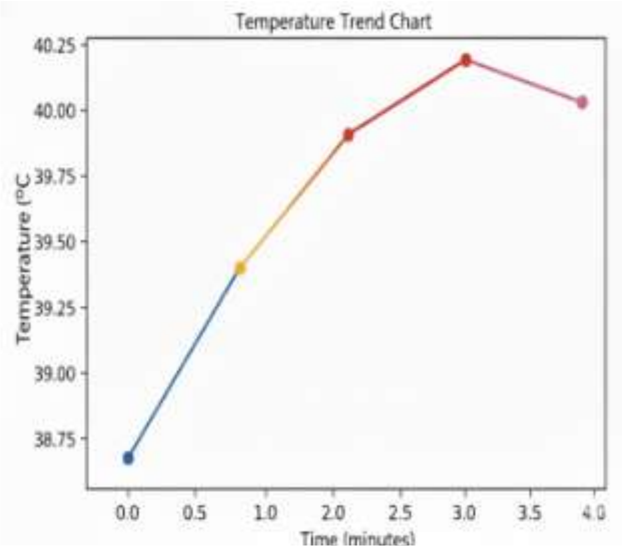
1. The Temperature Rise Calculation
The most common calculation used by engineers to check motor health is:

- **T-motor:** The current reading on your infrared thermometer (**40.0°C**).
- **T-ambient:** The temperature of the air around you (let's assume **25°C.**

Example Calculation:
40°C - 25°C = 15°C rise

2. Estimated Internal Temperature
Thermometer measures the **surface** of the casing. The internal copper windings where the heat is generated are usually **10°C to 20°C hotter** than the outside shell.
Formula for Estimated Internal Heat:
Tinternal = Tsurface + 15°
40°C + 15°C = 55°C. This is still well within the safe limits for the magnet glue and wire enamel (which usually handle up to 100°C–120°C).

3. EXTERNAL CASING TEMPERATURES 40°C RATED
Hub motors are rated for much higher internal temperatures. Here is a general guide for external casing temperatures:



Temperature Range	Status	Action
Below 50°C	**Excellent**	Motor is running very efficiently.
50°C - 70°C	**Normal**	Typical for long rides or moderate hills.
70°C - 90°C	**Warning**	Motor is getting hot; consider reducing throttle.
Above 90°C	**Critical**	Risk of damaging magnets or melting wire insulation.

5.2 WEIGHT MEASUREMENT

1.Vehicle Weight Calculation
Vehicle mass (m) = 140 kg
Acceleration due to gravity (g) = 9.81 m/s²
Total vehicle weight (W):
$W=m\times gW=140\times 9.81=1373.4$ N

2. Rolling Resistance Force
- Rolling resistance coefficient Crr=0.015(typical for two-wheelers)

$Frr=Crr\times WFrr=0.015\times 1373.4=20.6$ N

3. Aerodynamic Drag Force
- Air density ρ=1.225 kg/m3
- Drag coefficient Cd=0.9

- Frontal area A=0.6 m2
- Vehicle speed v=40 km/h=11.11 m/s

Fd=12CdAv2Fd=0.5×1.225×0.9×0.6×(11.11)2Fd=40.8 N

4. Power Required at Wheel

P=Ftotal×vP=70.23×11.11P=780 W

Considering motor & transmission efficiency ≈ 85%

Pmotor=7800.85=918W

VI. Material Selection

Material selection is one of the most critical aspects in designing an electric two- wheeler conversion kit, which has to be durable, safe, and efficient. All components need to be able to bear mechanical loads, vibrations, and shocks while riding; therefore, high fatigue strength is required for motor mounts, battery enclosures, and brackets. Durable materials reduce maintenance needs and prolong the life of the kit, while lightweight ones contribute to a reduction of the total vehicle weight, improving efficiency and extending battery range. Common choices for frames and trays are aluminum alloys and composite materials since they have good strength without adding excess mass. For electric parts, such as wires, connectors, and motor windings, high-conductivity materials are needed to reduce power losses and improve system efficiency. Copper is used as the most common material because of its excellent electrical conductive properties. Additionally, it is important that materials can tolerate heat from the battery, motor, and controller to avoid thermal degradation during the operational mode.

VII. Applications

The electric two-wheeler conversion kit finds many applications across segments to facilitate clean and efficient mobility. This essentially works with the conversion of the existing petrol-based scooters or motorcycles into electric ones, which is a cheap and ecological method of transportation. These kits are used for personal commuting, commercial delivery, educational research, and even government or institutional purposes. Rental and Sharing Services in Urban Areas: Rural and semi-urban transportation Educational and research projects in engineering institutions. Environmental awareness and demonstration programs.

VIII. Advantages

Various value additions will be derived from the design and development of an electric two-wheeler conversion kit. This will facilitate retrofitting existing petrol vehicles into eco-friendly electric ones at low costs, therefore reducing fuel expenditure and resultant emissions. Efficiency, range extension of batteries, and long service life are attained by using light and durable materials. The integration of components such as the hub motors, controllers, and DC-DC converters into the kit facilitates easy installation and is highly reliable and user-friendly. Reutilization of the already existing vehicles instead of manufacturing new ones supports the circular use of materials. All these guarantee affordable, efficient, and environmentally responsible mobility, thereby making electric transport accessible to the common masses.

IX. Conclution

The design and development of an electric two-wheeler conversion kit are an effective solution to modern transportation- related challenges in an environmentally friendly way. The kit converts any available petrol-based two-wheeler into an electric vehicle, facilitating eco-friendly mobility with zero emissions, reduced noise pollution, and low operating costs. The project also determines how all the critical components like a battery pack, motor, motor controller, and throttle system are put together to convert electrical energy into mechanical motion efficiently. Materials are selected carefully to ensure durability, safety, and lightweight construction that will lead to improved performance and range of the vehicle in totality. On the whole, the conversion kit is cost-effective and practical for the promotion of green transportation using available vehicles. It offers sustainable mobility in urban areas, reduction of dependence on fossil fuels, and increased adoption of electric vehicles in personal and commercial applications. This project shows the feasibility and advantages of retrofitting conventional two-wheelers, thereby opening up the avenues for further innovation in electric mobility.

References

[1]. V. Mulik, Design and Analysis of Retrofitted Two-Wheeler Electric Kit, 2022. Discusses efficiency loss in aged conventional vehicles and explains retrofitting gasoline two-wheelers into electric systems through powertrain, electrical and structural modifications.

[2]. D. Diwate, Design and Development of Mountable Electrical Conversion Kit for a Motorcycle, 2020.Presents a student project on converting a scooter to an electric two- wheeler; includes component selection, sizing calculations and performance results.

[3]. Sasane, Design and Analysis of Electric Vehicle Conversion Kit, 2024. Describes a hybrid retrofit kit (IC engine + electrical assist) with mechanical integration, testing data and fuel-efficiency improvements.

[4]. P. A. Trishulwar, Transformation of Two- Wheeled Electric Vehicle from IC Engine Vehicle. Designs a mountable EV conversion kit using existing motorcycle components; evaluates power output and structural safety.