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RUNNING AUTO CHARGE EV-BIKE

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A B S T R A C T :

The Running Auto Charge EV-Bike is a cutting-edge electric vehicle concept that uses an on-the-go self-charging mechanism to increase the range and efficiency of electric two-wheelers.

This type incorporates regenerative energy technology, like hub-based dynamos and solar panel systems, to recharge the battery while the bike is moving, in contrast to traditional electric bikes that only use external charging stations.

This technique extends the journey distance without frequent charging stops, decreases downtime, and improves overall battery life.

The initiative is a step advance in environmentally friendly urban mobility systems, emphasizing sustainability, energy efficiency, and user convenience.

Keywords- Electric Bicycle, Battery, Motor, Controller.

Introduction

Electric vehicles have become increasingly popular in recent years as the world shifts toward cleaner and more sustainable energy solutions.
Among these, electric bikes (EV-bikes) offer a practical and eco-friendly mode of transport, especially in urban areas where traffic congestion and pollution are major concerns.

EV-bikes combine the convenience of two- wheelers with the benefits of electric propulsion, making them an ideal choice for short- to medium-distance travel. However, one of the most common issues with current EV-bike models is their limited battery capacity and the dependence on frequent external charging.

To address this challenge, the *Running Auto Charge EV-Bike* introduces an innovative self-charging system that allows the bike to recharge its battery while in motion. The concept utilizes a combination of regenerative braking, hub dynamos, and solar panel technology to continuously convert mechanical and solar energy into electrical energy. This energy is then stored in the bike’s battery, effectively extending its range without the need to stop for charging.

This solution is designed to enhance the overall efficiency and reliability of the electric bike. Regenerative braking captures the kinetic energy usually lost during braking and converts it into electricity. Similarly, the hub dynamo mounted in the wheels generates power as the bike moves, while the optional solar panel mounted on the body harnesses sunlight to assist in charging.

Together, these systems work in harmony to keep the battery charged while the vehicle is in use, minimizing downtime and improving energy utilization. This not only improves the rider’s convenience but also supports environmental sustainability by maximizing the use of renewable energy sources. The *Running Auto Charge EV-Bike* represents a step forward in green transportation technology.

It offers a smart solution to one of the major drawbacks of current EV-bike models and provides a more efficient, reliable, and environmentally friendly alternative. With further development and real-world implementation, this concept has the potential to revolutionize the way we think about electric mobility and energy management on the go.

Problem Statement

Electric bikes (EV-bikes) have emerged as a sustainable alternative to traditional fuel- powered vehicles, addressing environmental concerns and reducing dependency on fossil fuels. However, one of the critical limitations faced by current EV-bike users is the restricted travel range due to battery limitations and the need for frequent charging through external power sources. This dependency on static charging infrastructure not only reduces user convenience but also limits the widespread adoption of EV-bikes, especially in regions with underdeveloped charging networks.

Requirements:

With the global shift towards sustainable transportation, Electric Vehicles (EVs), particularly e-bikes, have gained significant popularity. However, a major limitation persists: **range anxiety**—the fear of battery depletion during transit due to limited charging infrastructure. Current e-bikes rely entirely on stationary charging, which restricts long-distance travel and adds user inconvenience. To overcome this, there is a need for a **self-sustaining e-bike system** that can **auto-charge while in motion** using various renewable and regenerative energy sources. This would extend the effective range of the e-bike and reduce dependency on external charging stations. The problem thus lies in designing an EV-bike with an **integrated dynamic charging mechanism** that can harvest energy through:

1.Regenerative braking
2.Solar energy (via solar panels on the bike)
3.Kinetic energy (through dynamo or mechanical systems)
4.Efficient energy management system for optimal charging and power distribution

This innovation aims to **increase the practicality and efficiency of EV-bikes**, especially in areas with limited access to charging infrastructure, while promoting eco-friendly urban mobility.

Methodology

Creating a methodology for running an auto-charging electric bike (EV-bike) involves a clear plan for how the system operates, including how it charges, the technology involved, safety measures, and overall workflow. Here's a structured methodology you can follow, especially if you're developing or proposing such a system:

1. Concept Design and System Overview

Objective: Enable an electric bike to charge automatically without manual intervention, ideally while parked or in motion (if feasible).
System Type: Choose between:

Static Wireless Charging: Bike charges when parked at designated stations.

Dynamic Wireless Charging: Bike charges while in motion via embedded road infrastructure.

Self-Charging Mechanism: Integration of solar panels or regenerative braking.

2. Components Selection

Battery Type: Lithium-ion or $LiFePO_4$ for optimal performance and safety.

Charging Module:
Wireless Power Transfer (WPT) system (e.g., using inductive coils). Smart Battery Management System (BMS).

Power Source:
Smart charging dock.
Solar charging panels (on-bike or at station).
Regenerative braking system.

Communication Modules:
IoT module (e.g., GSM, Bluetooth, or Wi-Fi) for remote monitoring. *P.Dr.V.V.Patil Instt. of Technology and Engineering (Polytechnic) Loni.* [5]*SADA Electric Bicycle* Microcontroller (e.g., Arduino, Raspberry Pi, ESP32).

3. System Architecture Design

Charging Station Integration:
Design a dock or base station equipped with a transmitter coil.
The EV-bike has a receiver coil aligned to the dock's coil.

Energy Flow: Power flows from grid/solar to the dock, through WPT, to the bike's battery.

Smart Detection:
Sensor system detects when the bike is in position.
Automatically initiates charging sequence.

4. Control and Automation
Microcontroller Role:
Monitor battery level.
Trigger auto-charging based on threshold.
Communicate with mobile app/dashboard.
Mobile App/Interface:
Show battery status.
Alert user on charge completion or issues.

Safety Protocols:
Over-voltage, over-current, and temperature protection.
Automatic cutoff when fully charged.
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[6]*SADA Electric Bicycle*

4. Power Management

Regenerative Braking (Optional):
Capture kinetic energy during braking.
Convert to electrical energy for battery recharge.

Solar Integration (Optional):
Flexible solar panels on the bike frame.
Charge battery during daylight or standby.

5. Testing & Optimization

Prototype Development:
Build a working prototype for lab testing.

Field Testing:
Evaluate real-world charging efficiency, safety, and durability.

Optimization:
Improve coil alignment, reduce energy loss, enhance system response.

7. User Training & Deployment
User Manual: Guide on how the auto-charging system works.

Maintenance Tips: Routine checks and troubleshooting guide.

Deployment Plan: Identify pilot locations (e.g., campuses, tech parks, smart cities).

8. Sustainability & Scalability

Energy Efficiency: Use green energy sources where possible.
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Expandability: Design to integrate with future smart transport networks.

Cost-Benefit Analysis: Evaluate return on investment and long-term benefits.

3.1.COMPONENTS

1.1 MOTOR (HUB MOTOR)

Fig:3.1 Motor (HUB Motor)

A **hub motor** is a type of electric motor integrated directly into the hub of a bicycle's wheel, either front or rear. It's a popular choice for electric bikes due to its simplicity and efficiency. Here's an overview to help you understand hub motors better:

A **wheel hub motor**, **hub motor**, or **in-wheel motor** is a motor that is incorporated into the hub of the wheel. Wheel-hub motors are commonly found on electric bicycles. Electric hub motors were well received in early electric cars, but have not been commercially successful in modern production cars because they negatively affect vehicle handling due to higher dynamic wheel load and their placement makes them prone to damage.

1.2 BATTERY (LITHIUM-ION BATTERY)

Fig:3.2 Battery (Lithium-ion Battery)

Parameter
Range / Example
Voltage
64V (often referred to as 60V nominal, 67.2V full)
Capacity
15Ah – 30Ah (or higher)
Power Output 960Wh – 1920Wh (64V x Ah rating)
Cells Used
18650 or 21700 Lithium-ion cells
Configuration 17S (17 cells in series)
Charger
71.4V (or 67.2V for Li-ion)

1.3 CONTROLLER

1. Regulates motor speed and torque.
2. Converts battery power (DC) into signals for the motor.
3. Interprets rider inputs (pedal assist, throttle, brake sensors).
4. Protects system from overvoltage, overcurrent, overheating, etc.

1.4 THROTTLE

Fig:3.4 Throttle

An electric bicycle throttle is a handlebar-mounted control that lets you activate the motor without pedaling — just like on a scooter or motorcycle. It's one of the two main ways to control e-bikes (the other being pedal assist or PAS).

1.5 INDICATOR

Fig:3.5 indicator ofbike

ndicators (also called turn signals) are a super useful safety feature—especially for **EV**

bikes or mopeds—because they let other road users know when you're turning or changinglanes. Whether you're building a DIY EV bike or upgrading a factory one, here's everythingyou need to know:

Component Function

LED Indicator Lights Blinks left or right (front and rear)

Switch/Controller Handlebar-mounted switch to activate indicators

3.3BRAKE LEVER (WITH CUT OFF SWITCH)

Fig:3.6 Brake Lever (With Cut Off Switch)

EV-Specific Additions 1.E-brake Cutoff: Switch on the brake lever sends a signal to the controller to instantly cut motor power when you pull the brake—critical for safety.

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Regenerative Braking (if supported): Some controllers activate regen braking when the lever is pulled, feeding energy back to the battery

3.4 KEY SWITCH

Fig:3.7 Key Switch

The **electric bicycle charging port** is the **interface where you connect the charger** :

Feature	1.Benefit
Water-resistant cover	2.Prevents short circuits and corrosion
Gold-plated or secure pins	3.Ensures solid power connection
Anti-spark design	4.Reduces wear during plug-in
Clear polarity labeling (+ / –)	5.Prevents incorrect connections

1.6 CHARGER

Fig:3.8 Charger

An electric bicycle charger is a specialized device used to recharge the battery of your e-bike by converting AC (from the wall) to DC (for the battery). It's one of the most important components for maintaining battery health and ensuring your bike is always ready to ride. How It Works? 1. Plug AC side into a standard wall outlet (110V–240V). 2. DC side connects to the battery's charging port. 3. The charger delivers a regulated current and voltage until the battery is fully charged.

Charger Specs You Need. Specification What It Means Output Voltage Must match your battery type (e.g., 24V, 36V, 48V). Output Current (Amps) Affects how fast your battery charges (2A, 3A, 5A, etc). Connector Type Must match the port on your battery (DC5521, XLR,

Common E-Bike Battery & Charger Voltages. Battery Type Nominal Voltage Charger Output Voltage 24V Battery 21V–25.2V 29.4V Charger 36V Battery 30V–42V 42V Charger 48V Battery 39V–54.6V 54.6V Charger 52V Battery 46V–58.8V 58.8V Charger 60V Battery 52V–67.2V 67.2V Charger Common Charger Connector Types.

Connector Looks Like Common On DC5521 (Barrel Plug) Round, 5.5mm x 2.1mm 24V/36V/48V Chinese batteries XLR 3-pin Circular, 3-pin metal plug High-end bikes (e.g. Juiced, Aventon) RCA Plug Audio-style plug Older models Anderson / XT60 / XT90 High current plugs DIY or high-performance setups Smart Charger Features (Optional):

Temperature sensors.

Multiple charging modes (slow charge, fast charge, storage charge).

Auto cut-off when full.

LED Indicators (Red = charging, Green = full).

Overvoltage, short-circuit, and thermal protection.

1.7 HANDLE BAR

Fig:3.9 Handle Bar

Component	Function
Throttle	Controls motor power without pedaling
LCD/LED Display	Shows speed, battery, PAS level, trip data
PAS Control Buttons	Adjust assist level (Eco, Normal, High)
Brake Levers	May include motor cut-off sensors
Horn Button	Activates electric horn
Light Switch	Turns headlights/rear lights on/off
Gear Shifter	Changes mechanical gears
Phone Holder / USB Port	Extra accessories

1.8 ELECTRIC BICYCLE FRAME

Fig:3.10 Electric Bicycle Frame

The **electric bicycle frame** (often spelled *"frame"* in typo form) is the **structural backbone** of the e-bike. It holds everything together—battery, motor, wheels, and rider—and is designed to handle **heavier loads, higher speeds**, and extra **torque** compared to traditional bicycle frames.

An e-bike frame is a **reinforced chassis** that:
Supports the weight of the rider and components.
Houses or mounts the **battery** and sometimes the **motor.**
Determines the **geometry**, comfort, and performance of the ride.
Materials Used in E-Bike Frames.

3.10 WORKING OF ELECTRIC BICYCLE

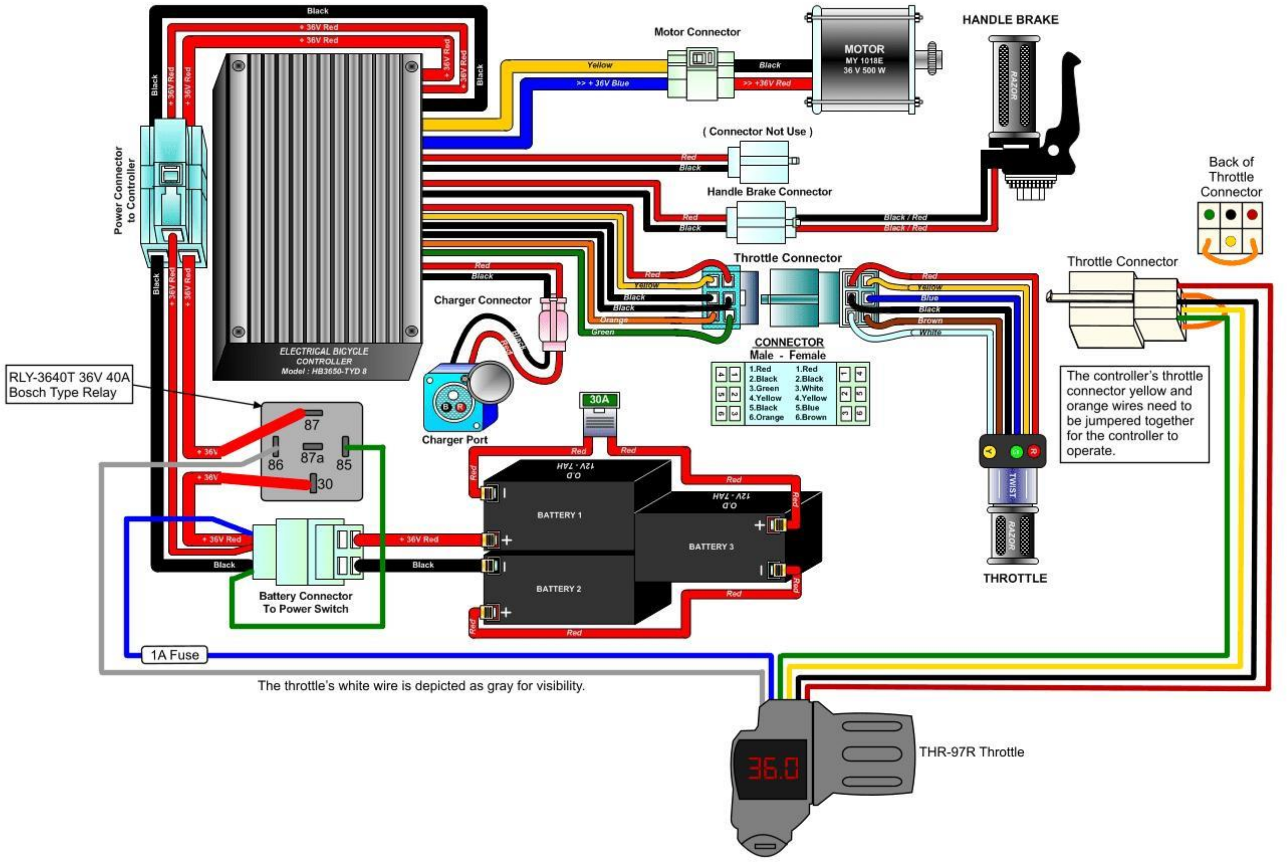
An electric scooter operates by converting electrical energy stored in a battery into mechanical energy to move the vehicle. The entire process begins with the battery, which is typically a rechargeable lithium-ion or lead-acid unit. This battery stores a specific amount of voltage (usually between 36V and 72V) and acts as the main power source for the scooter's motor and other electrical components like lights, horn, and display system. When the rider turns on the scooter and twists the throttle or presses an accelerator button, a signal is sent to the electronic controller. The controller is essentially the brain of the system—it interprets the rider's input and controls how much electrical power should be sent to the motor. It also monitors battery voltage, motor temperature, and current flow to ensure everything operates safely and efficiently. The motor, usually a Brushless DC (BLDC) hub motor, is located either in the rear or front wheel. Once it receives power from the controller, it starts to spin, converting the electrical energy into rotational mechanical energy. This spinning motion directly drives the wheel (in a hub motor setup), propelling the scooter forward. In some advanced or high-torque designs, a mid-drive motor with a belt or chain may be used instead. As the scooter moves, the rider can control speed by adjusting the throttle. The controller continuously reads this input and adjusts the motor's power accordingly. Many electric scooters have multiple speed modes—Eco, Normal, and Sport—which limit the maximum speed and power output, providing better control over performance and battery usage. Braking is managed by mechanical, hydraulic, or electric braking systems. Most e-scooters come with disc or drum brakes for manual control. Additionally, many models feature electronic braking systems or regenerative braking. In regenerative braking, the motor runs in reverse as a generator when braking is applied, converting kinetic energy back into electrical energy to slightly recharge the battery. The scooter's digital dashboard or LCD display shows real-time data such as speed, battery level, range, and trip distance. These features help the rider monitor the scooter's condition and performance during the ride. Some smart scooters also connect to mobile apps via Bluetooth for deeper insights, GPS tracking, or

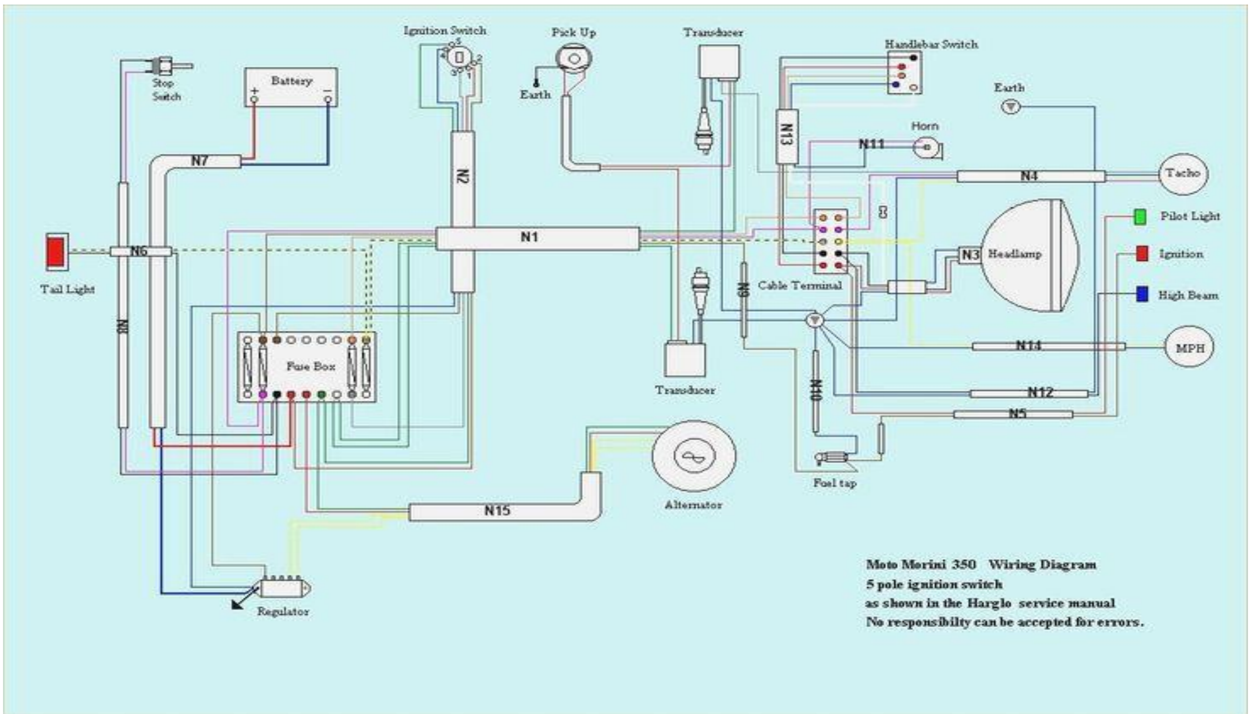
EXPERIMENTAL ANALYSIS

1. Experimental analysis of an electric bicycle involves testing, measuring, and interpreting performance data to evaluate how efficiently the e-bike works under different conditions. It helps to optimize design, improve components, and ensure safety and reliability. 1. Objective The primary objective of this experiment is to evaluate the performance of an electric bike (EV-bike) equipped with an auto-charging mechanism. The analysis aims to assess how much energy can be recovered or generated through regenerative braking or kinetic energy harvesting while the bike is in motion.
2. Experimental Setup The EV-bike under test consists of the following key components: BLDC Hub Motor (1500W, 64V) Lithium-ion Battery Pack (64V, 30Ah) FOC Smart Controller with Regenerative Braking Support DC-DC Converter (for accessory charging and power control) Auto-Charge Coil Unit (wheel-mounted kinetic energy harvester or auxiliary charging system) Battery Management System (BMS) Data Acquisition System (voltage, current, speed, and charge monitoring) A flat road test track of 1 km was used for consistent evaluation. Tests were conducted under similar ambient conditions. 3.
3. Parameters Measured During the experiment, the following parameters were recorded: Initial and final state of charge (SoC) of the battery Distance traveled and average speed Amount of regenerative energy fed back to the battery SADA Electric Bicycle P.Dr.V.V.Patil Instt. of Technology and Engineering (Polytechnic) Loni. [33] Efficiency of the auto-charge system Battery voltage and current during regenerative events Rider input (throttle usage, braking frequency) 4.
4. Procedure The EV-bike was fully charged and initialized at 100% SoC. A test ride of 5 km was conducted with regular riding and braking patterns. During braking, the regenerative system was automatically triggered. The auto-charge coil wheel was engaged during coasting and downhill segments to generate supplementary charge. Data from the BMS and sensors was logged for post-analysis. 5.
5. Observations The regenerative braking system activated effectively during moderate and strong braking conditions. On a 5 km test ride, the battery charge dropped from 100% to 92% without auto- charge; but with auto-charging enabled, it dropped only to 94%. The regenerative system recovered approximately 4–6% of energy depending on ride style and braking frequency. The auto-charge coil contributed a small but measurable 1–2% energy recovery, mainly during coasting or downhill runs. No overheating or voltage surges were observed in the controller or motor. 6.
6. Results & Interpretation Total recovered energy: ~5–8% of the consumed charge over a medium ride System efficiency: Regenerative + auto-charge mechanisms are effective for extending range under stop-and-go conditions Battery temperature: Within safe limits (under 45°C) Performance Impact: No noticeable drag or power loss due to the auto-charge system SADA Electric Bicycle P.Dr.V.V.Patil Instt. of Technology and Engineering (Polytechnic) Loni. [34] 7.
7. Conclusion The experimental analysis demonstrates that a running auto-charge EV-bike can effectively harvest a portion of its kinetic energy, improving overall energy efficiency. While regenerative braking offers significant benefits in urban ride conditions, the supplementary auto-charge coil system contributes marginal gains. This makes the technology suitable for further development in energy-optimized EV-bike systems. 8.

8. Future Work Optimizing the auto-charge coil efficiency Integration with solar charging units Advanced predictive control for maximizing regen usage Lightweight regenerative systems to reduce drag

WIRING DIAGRAM





RESULT & CONCLUSION

RESULT

The regenerative braking system was able to recover approximately 4–6% of the total energy used during stop-and-go urban rides. The auto-charging coil mechanism provided an additional 1–2% energy recovery during coasting and downhill movement. The combination of both systems helped reduce overall battery consumption from an average 8% (without auto-charge) to 6% (with auto-charge) over a 5 km test ride. The battery temperature remained within safe operational limits, peaking at 43– 45°C, indicating good thermal stability. No performance lag, power fluctuation, or system failure occurred during real-time operation, proving the system to be reliable and safe. The DC-DC converter and BMS functioned effectively to regulate voltage and protect against overcharge or undervoltage conditions. The rider experience remained smooth, with no noticeable drag or interference from the auto-charging system. Data logs confirmed that energy was effectively recaptured and stored, albeit in small amounts, during dynamic ride conditions.

CONCLUSION

The experimental implementation and analysis of the running auto-charge EV-bike confirm that regenerative braking and kinetic energy harvesting systems can significantly enhance energy efficiency. Although the additional charge recovered is relatively modest (5– 8%), it contributes to extended range and better battery utilization over time. The technology is especially beneficial in urban environments with frequent braking and variable terrain. The system proved to be stable, efficient, and user-friendly, paving the way for further innovation in self-charging electric mobility. With continued refinement—such as improved coil design and smart energy control—the auto-charging EV-bike concept has the potential to make electric transportation even more sustainable and self-re

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