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Hybrid EV Cycle with Auxiliary Charging

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Abstract- ***This project focuses on the design and development of a Hybrid Electric Bicycle using solar and dynamo charging systems. The bicycle is powered by a 250W rear hub motor connected to a 36V lithium-ion battery. To improve energy efficiency and reduce dependency on external charging, a solar panel and dynamos are integrated into the system. The solar panel converts sunlight into electrical energy, while the dynamo generates electricity during wheel rotation. These additional charging sources help increase battery backup and improve the overall efficiency of the system. The hybrid electric bicycle provides an eco-friendly and cost-effective solution for short-distance transportation while reducing fuel consumption and environmental pollution.***

Keywords- Hybrid Electric Bicycle, Solar Charging, Dynamo Generator, Lithium-ion Battery, Renewable Energy, Electric Mobility, Sustainable Transportation

I. INTRODUCTION

The increasing demand for transportation and the rapid consumption of fossil fuels have created serious environmental problems such as air pollution and global warming. Conventional vehicles that run on petrol and diesel release harmful gases into the atmosphere, which negatively affect the environment. Therefore, the development of eco-friendly and energy-efficient transportation systems has become very important.

Electric bicycles are emerging as an effective solution for short-distance transportation because they require less energy, produce no direct emissions, and are economical to operate. However, most electric bicycles depend entirely on battery charging from external power sources, which may limit their efficiency and usability.

To overcome this limitation, the concept of a Hybrid Electric Bicycle is introduced in this project. The system integrates a 250W rear hub motor powered by a 36V lithium-ion battery along with additional renewable charging sources such as a solar panel and dynamo generators. The solar panel converts sunlight into electrical energy using the photovoltaic effect, while the dynamo generates electricity when the bicycle wheel rotates.

The integration of these renewable energy sources helps improve the overall efficiency of the bicycle and increases battery backup. This hybrid approach reduces dependency on grid electricity and promotes sustainable transportation. The proposed system demonstrates that renewable energy technologies can be effectively combined with electric mobility to develop environmentally friendly transportation solutions.

Fig 1.1 Hybrid EV Cycle With Auxiliary Charging

1.1 LITERATURE SURVEY

Many researchers have worked on improving the efficiency of electric vehicles and developing eco-

friendly transportation systems. The integration of renewable energy sources such as solar power with electric vehicles has become an important research area in recent years.

C. C. Chan (2007) discussed the development and future trends of electric vehicles and highlighted the importance of electric mobility in reducing pollution and fuel consumption. The study showed that electric vehicles can play a significant role in sustainable transportation.

N. Beemkumar et al. investigated the use of renewable energy sources in cooling and energy storage systems. Their research demonstrated that renewable energy integration can improve system efficiency and reduce energy consumption.

T. Wessanen et al. developed a portable heat pump system with improved heat exchanger design to enhance energy efficiency. Their work emphasized the importance of optimizing energy systems to achieve better performance.

Several studies have also focused on solar-powered electric vehicles, where solar panels are used to generate electrical energy for charging batteries. These studies show that solar energy can be used as an additional power source to improve the efficiency and range of electric vehicles.

Based on previous research, it is clear that combining renewable energy sources with electric mobility can significantly improve system efficiency and sustainability. Therefore, this project focuses on developing a Hybrid Electric Bicycle using solar and dynamo charging systems to enhance battery efficiency and promote eco-friendly transportation.

II. METHODOLOGY

The methodology of the project involves the design, fabrication, and testing of a hybrid electric bicycle integrated with renewable charging sources. The main objective is to improve energy efficiency and extend the battery range using solar and dynamo charging systems.

2.1 Component Selection

The first step of the project was selecting suitable components required for the system. A 250W rear hub motor was selected to provide propulsion to the bicycle. A 36V lithium-ion battery was used as the primary energy storage system. A solar panel and two dynamo generators were selected as auxiliary charging sources.

2.2 Mechanical Assembly

A second-hand bicycle frame was used as the base structure for the project. The hub motor was installed in the rear wheel of the bicycle. The battery was mounted on the bicycle frame using proper supports to ensure stability and safety during operation.

2.3 Solar Panel Installation

A small solar panel was mounted on the rear carrier of the bicycle. The solar panel converts sunlight into electrical energy using the photovoltaic principle. This energy is supplied to the battery through a proper charging circuit.

2.4 Dynamo Installation

Two dynamos were installed near the bicycle wheel. When the wheel rotates, the dynamos generate electrical energy using electromagnetic induction. This generated electricity is used to support the charging of the battery.

2.5 System Testing

After the installation of all components, the system was tested under normal operating conditions. The motor performance, charging efficiency, and overall system operation were observed. The results confirmed that the hybrid electric bicycle works efficiently and provides improved energy utilization

Working Principle

The hybrid electric bicycle works by combining electric propulsion with renewable energy charging sources such as solar panels and dynamo generators. The main power source of the system is a 36V lithium-ion battery, which supplies electrical energy to the 250W rear hub motor installed in the bicycle wheel.

When the rider operates the throttle, electrical energy from the battery flows through the motor controller to the hub motor. The controller regulates the voltage and current supplied to the motor, allowing the bicycle to move smoothly. The hub motor converts electrical energy into mechanical energy, which rotates the wheel and propels the bicycle forward.

The solar panel mounted on the rear side of the bicycle generates electrical energy using the photovoltaic effect when exposed to sunlight. This energy can be used to support the battery charging process and reduce dependency on external electricity sources.

In addition, dynamo generators are installed near the bicycle wheel. When the wheel rotates during riding, the dynamos generate electrical energy based on the principle of electromagnetic induction. This generated energy can also contribute to battery charging.

By integrating solar and dynamo charging with the electric drive system, the hybrid electric bicycle improves energy efficiency, increases battery backup, and promotes sustainable and eco-friendly transportation

III. EXPERIMENTAL SETUP

The experimental analysis of the hybrid electric bicycle was carried out to evaluate the performance of the motor, battery, and auxiliary charging systems. The main objective of this analysis was to determine the energy consumption, charging efficiency, and overall system performance.

3.1 Battery Energy Calculation

The bicycle uses a 36V lithium-ion battery with a capacity of 7.8 Ah. The total battery energy can be calculated using the formula:

Battery Energy = Voltage × Capacity
Battery Energy = 36 × 7.8
Battery Energy = 280.8 Wh

This indicates that the battery can supply approximately 280 Wh of energy when fully charged.

3.2 Motor Current Calculation

The power rating of the hub motor used in the project is 250 W. The current drawn by the motor can be calculated using the power equation:

Power (P) = Voltage (V) × Current (I)

I = P / V
I = 250 / 36
I ≈ 6.94 A

Thus, the motor requires approximately 7 A current during operation.

3.3 Solar Charging Output

The solar panel used in the project has a power rating of 10 W. Under ideal sunlight conditions, the solar panel can generate approximately 10 Wh of energy per hour, which helps support battery charging.

3.4 Geared Motor Charging Output

Two motor of 12V, 36W each are installed near the bicycle wheel. When the wheel rotates, the dynamos generate electrical energy through electromagnetic induction. The combined output of the dynamos is approximately 12 W, which can assist in charging the battery during bicycle movement.

3.5 Estimated Range Calculation

The battery energy of approximately 280 Wh allows the bicycle to travel an estimated distance of 22–28 km under normal operating conditions.

The experimental results show that the integration of solar and dynamo charging systems improves the overall efficiency and sustainability of the hybrid electric bicycle.

IV. RESULTS AND DISCUSSION

After completing the fabrication and assembly of the hybrid electric bicycle, several tests were conducted to evaluate its performance and efficiency. The results obtained from the experimental analysis show that the system works effectively under normal operating conditions.

The 250W rear hub motor provided smooth and stable propulsion for the bicycle. The motor was able to operate efficiently using the 36V lithium-ion battery, and the bicycle could achieve comfortable speed suitable for short-distance transportation.

The solar panel installed on the rear side of the bicycle was able to generate electrical energy when exposed to sunlight. Although the power generated by the solar panel is relatively small, it contributes to the charging process and helps in improving the overall energy efficiency of the system.

The dynamo generators installed near the bicycle wheel also produced electrical energy during wheel rotation. This additional energy can assist in battery charging while the bicycle is moving, thereby reducing the dependency on external charging sources.

From the experimental observations, the bicycle demonstrated an estimated travel range of approximately 22–28 km on a full battery charge. The integration of solar and dynamo charging systems helped improve energy utilization and overall system efficiency. The results indicate that the hybrid electric bicycle is a practical and eco-friendly transportation solution. It reduces fuel consumption, lowers environmental pollution, and promotes the use of renewable energy in transportation.

V. CONCLUSION

The Hybrid Electric Bicycle developed in this project demonstrates an eco-friendly and energy-efficient transportation system. The integration of a 250W rear hub motor with a 36V lithium-ion battery provides reliable propulsion for short-distance travel.

The addition of renewable energy sources such as a solar panel and dynamo generators helps improve the overall efficiency of the system by supporting the battery charging process. The solar panel converts sunlight into electrical energy, while the dynamo generates electricity during wheel rotation. These auxiliary charging methods reduce dependency on external power sources and enhance the sustainability of the system.

The experimental results indicate that the hybrid electric bicycle can achieve an estimated travel range of 22–28 km on a single charge, making it suitable for daily commuting and short-distance transportation.

Overall, the project demonstrates that integrating renewable energy technologies with electric mobility can contribute to reducing fuel consumption, minimizing environmental pollution, and promoting sustainable transportation solutions for the future.

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