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A RESEARCH ON 'HYBRID BICYCLE'

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Abstract

The Hybrid Electric Bicycle is an innovative transportation solution designed to reduce dependence on traditional fuel sources and promote sustainability. It combines three charging methods to power an electric hub motor that drives the front wheel: solar power, regenerative braking, and a 220VAC wall outlet. By integrating these methods, the hybrid bicycle harnesses renewable energy and enhances its performance. A lightweight hub motor is mounted on the front wheel, improving the bicycle's efficiency and handling. The regenerative braking system captures energy from pedalling (human energy) and braking, converting it into electricity to recharge the lithium-ion battery. Additionally, solar panels installed on the bicycle collect sunlight and convert it into power, further charging the battery when the bicycle is not in use. These combined energy sources—solar power, regenerative braking, and wall outlet charging allow the hybrid bicycle to travel longer distances with less reliance on external power. This system significantly extends the bicycle's range and provides an eco-friendly way to recharge while cycling. By incorporating renewable energy and innovative technology, the Hybrid Electric Bicycle offers a sustainable, energy-efficient alternative to conventional transportation. This approach not only reduces environmental impact but also contributes to the development of cleaner, more sustainable transportation solutions. The hybrid bicycle represents a practical step forward in eco-friendly travel, helping to address global energy consumption and environmental challenges.

Keywords: Solar power, Regenerative charging, Wall charging, DC-DC boost converter, Hub motor

Introduction

In today's world, the growing number of automobiles is increasing the need for petroleum products, which are non-renewable and may run out in the future. With rising crude oil prices and environmental concerns, it's important to find alternative energy sources. The demand for cleaner transportation is pushing the use of electric power to reduce our reliance on traditional vehicles. Electric bicycles offer a low-cost alternative to cars.

While electric bicycles are not a new idea, they haven't been fully explored yet. This project focuses on designing and testing a hybrid electric bicycle. The challenge is converting the current mechanical system to one that combines human pedalling with solar energy

A hybrid system uses multiple energy sources to power a vehicle. In this project, the bicycle's battery is charged using three sources:

The hub motor on the front wheel is powered by the battery. This hybrid bicycle project helps promote cleaner technology and reduces our dependence on petroleum products.

A hybrid bicycle is a bicycle that runs using electricity stored in a battery. The battery powers a mid-drive motor on the rear

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wheel, which makes the bicycle move. The battery is charged using solar energy from photovoltaic (solar) panels.

Usually, two solar panels are used to collect sunlight and convert it into electricity. This electricity charges the battery. These bicycles are not common in daily life, but they are often made as projects and sometimes supported by the government to help reduce pollution.

Hybrid bicycles are not new, and many countries have patents for them. But combining solar charging and electricity generation by pedalling is a newer idea with not much research done yet.

There are two types of solar panels used:

- Polycrystalline panels (15–20% efficiency)
- Microcrystalline panels (50–60% efficiency, more efficient than polycrystalline)

Batteries used in hybrid bicycle:

- Lithium-ion batteries: lightweight, last longer, but more expensive and can be risky (possible explosion).

A mid-drive motor is used to move the rear wheel. A belt and pulley system are added at the back to run a dynamo, which can also generate electricity.

Methodology

The methodology for constructing the Hybrid Bicycle is shown in a block diagram (Figure 1). The main goal of the project was to ensure the Hybrid Bicycle operates efficiently and meets the necessary drive requirements. Given that there are legal speed limits for electric bicycles, the maximum speed for the Hybrid Bicycle was set at 28 km/h. Since the bicycle includes a regeneration system, choosing the right components while considering weight and size constraints was very important.

The key components needed for the project are:

- **Motor**
- **Battery**
- **Solar Cell**
- **Throttle**
- **Frame**
- **DC-DC Boost Converter**

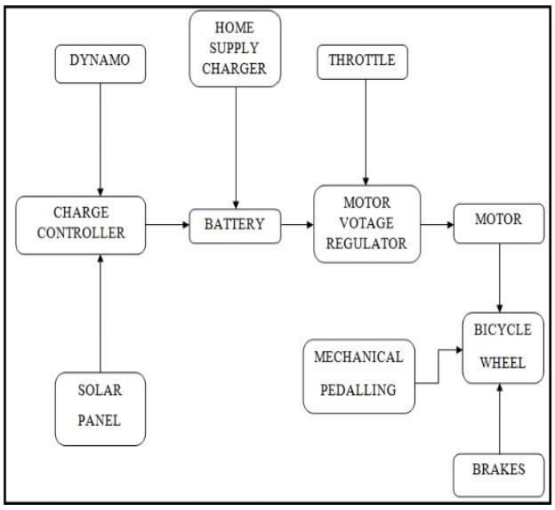

Figure 1. Block diagram of Hybrid bicycle

The battery and motor required for Hybrid Bicycle has been chosen assuming that the external forces such as wind drag, rolling resistance of tyres, etc. has been neglected. The focus is more on energy conversion between kinetic/potential and electrical energy. To accelerate the Hybrid Bicycle from cold start, sufficient torque needs to be provided and hence a sufficient amount of current needs to be drawn by the motor. If the terrain is flat, there is no potential

energy which would have caused the motor to deliver a counter torque to oppose the force of gravity. We therefore look at only the kinetic energy required for acceleration. The energy relationships have been provided.

Kinetic Energy = ½ mΔV2

Electrical Energy = V×I×T

K.E. = voltage rating motor × current required × time to accelerate

Motor selection

A **250-watt Permanent Magnet DC Hub Motor** was chosen for the Hybrid Bicycle for several reasons:

1. **Easy Control**: The motor is simple to control.
2. **Regeneration**: It can act as a generator to regenerate power when needed.
3. **Good Torque-Speed Balance**: It offers the right mix of torque and speed for smooth operation.
4. **Lightweight and Powerful**: It provides high power for its size.

Considering time constraints and design challenges, this motor was ideal for the project. It provides enough torque for the system and is more affordable compared to brushless motors. It's also easy to integrate into the bicycle.

Key Motor Details:

- **Power**: 250 Watts
- **Speed**: 2100 RPM (Revolutions Per Minute)
- **Size**: 4.5 inches x 5.5 inches
- **Voltage**: 36 V (helps to produce more power and control heating effects)
- **Current**: 7 Amps continuous
- **Peak Ratings**: For short, high-power use

The **36 V motor** was chosen because it's commonly used in electric bikes and fits the project's needs for performance and compatibility.

Battery selection

When selecting batteries for the Hybrid Bicycle, the main factors considered were **cost**, **durability**, **energy density**, and the **number of recharge cycles**. **Sealed lead acid batteries** are commonly used because they are affordable and offer decent energy density.

After looking at various electric bike designs, it was found that many of them use **three 12V batteries** with capacities ranging from **7 to 20 Amp-hours**. For this project, we decided to use **three 12V, 7-Amp-hour Sealed Maintenance Free Batteries (SMFB)**. These are rechargeable lithium-ion batteries, and they come in a **plastic casing** to protect the internal components.

Solar Panel Specifications

We're using a solar panel that converts sunlight into electricity. Here are its key specifications:

- Maximum Power: 20 Watts

- Voltage: 17 Volts (when producing maximum power)

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- Open Circuit Voltage: 12 Volts (when not connected to a load)

- Short Circuit Current: 1.2 Amps (when connected to a load with no resistance)

Throttle

To adjust the motor's speed according to road conditions and traffic, we need a throttle or accelerator. This throttle:

- Is located on the right handlebar

- Connects to the controller

- Converts battery voltage to a variable voltage that controls the motor's speed

This allows the motor to go from zero to full speed smoothly.

Working Model

Conclusion

A solar-assisted bicycle is a modified version of a regular bicycle that runs on solar energy, making it suitable for both city and country roads, whether they're made of cement, asphalt, or mud. This eco-friendly bicycle is not only affordable, priced at around ₹8,000, but also simpler in construction, making it an ideal mode of transportation for short distances of up to 25km, particularly for school children, college students, office workers, villagers, and postmen. Its suitability extends to people of all ages, including the young, aged, and physically challenged, catering to the needs of economically disadvantaged segments of society. One of the most significant advantages of this bicycle is that it can be operated throughout the year without incurring any fuel costs, as it harnesses solar energy. Additionally, it's an environmentally friendly option that doesn't consume valuable fossil fuels, doesn't emit pollutants, and is noiseless. In cases of emergency or cloudy weather, the bicycle can be recharged using an AC adapter, and if there's a problem with the solar system, it can be driven manually using pedal power. With fewer components, it's easy to maintain, and its parts can be easily mounted or dismounted, making it a convenient and practical mode of transportation.

Future scope

The hybrid powered electric bicycle in this project utilizes solar power as one of its energy sources, offering a sustainable and eco-friendly transportation solution. Looking ahead, there's potential to further enhance the bicycle's capabilities by incorporating wind power as an additional energy source, which could be achieved by installing a wind turbine in a suitable location. Moreover, the hybrid bicycle can be modified to cater to the needs of physically disabled individuals, promoting inclusivity and accessibility. Furthermore, the bicycle can be digitalized by integrating features such as indicators, advanced sensors, digital displays, navigation systems, and more, thereby enhancing the overall riding experience. Additionally, implementing a gear variation system would enable riders to increase torque and control speed, making the bicycle more versatile and user-friendly.

References

1. Robin Hardy, “Electric and hybrid vehicles”, CRC Press, 2003
2. Mehrdad Ehsani, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design”, CRC Press, 2004.
3. Ajay Babu, "Preliminary Design and Simulation of Hybrid Bicycle with Fuzzy Control Approach," MTech thesis, Dept. of Electrical Engg., College of Engineering, Thiruvananthapuram, 2006.