

Design and Implementation of Electric Bicycle Speed Control System

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ABSTRACT

The increasing cost of conventional fuels and growing environmental concerns have encouraged the development of economical and environmentally friendly transportation systems. This paper presents the design and implementation of an electric bicycle with a speed-control and battery-monitoring system. The proposed electric bicycle provides two operating modes: conventional pedal operation for shorter distances and battery-powered operation for longer distances. A Permanent Magnet DC (PMDC) motor is employed to provide the required propulsion, while a motor controller and throttle enable the rider to regulate the bicycle speed.

The system also incorporates monitoring of the battery status and bicycle speed to provide useful operating information to the rider. The electrical and mechanical components are integrated with a conventional bicycle to provide a compact and practical electric mobility solution. Experimental results reported for the developed bicycle show a maximum road speed of approximately 30 km/h, an economical operating range of 17–25 km/h, and a travel distance of up to 45 km on a complete battery charge. The developed system therefore demonstrates the feasibility of converting a conventional bicycle into an economical electric transportation system with improved riding convenience.

Keywords— Electric bicycle, PMDC motor, speed control, motor controller, battery monitoring, throttle, electric vehicle, sustainable transportation.

INTRODUCTION

Electric bicycles have emerged as an attractive alternative to conventional bicycles and fuel-powered two-wheelers because they combine the simplicity of a bicycle with electric propulsion. Conventional bicycles are economical and environmentally friendly; however, continuous pedaling can cause fatigue, particularly during long-distance travel, uphill riding, or demanding road conditions. Electric assistance can reduce the physical effort required from the rider while retaining the basic advantages of bicycle transportation.

The proposed electric bicycle is designed to operate either through conventional pedaling or using battery-powered electric propulsion. When the rider requires assistance, the electric motor can provide the necessary driving torque. The speed of the bicycle can be regulated according to the rider's requirement, while the battery condition and vehicle speed can be monitored to assist in planning the journey. The combination of pedal and electric modes improves flexibility and makes the bicycle suitable for both short- and medium-distance transportation.

The developed system employs a battery, PMDC motor, motor controller, throttle, speedometer and associated mechanical drivetrain. The controller regulates electrical power supplied from the battery to the motor according to the throttle input. Such a configuration provides controlled electric propulsion while retaining the conventional pedal mechanism. The resulting system is intended to provide an economical, efficient and convenient mode of transportation while reducing dependence on conventional fuel-powered vehicles.

LITERATURE SURVEY

Katoch *et al.* [1] presented the design and implementation of a smart eco-friendly electric bicycle and emphasized electric transportation as an alternative to vehicles dependent on non-renewable energy resources. Their work highlighted advantages such as higher motor efficiency, reduced maintenance and environmentally friendly operation. Patil *et al.* [4] investigated the design, analysis and fabrication of an electric bicycle by modifying a conventional bicycle through the addition of an electrical propulsion system. Their study emphasized the importance of alternative transportation technologies in view of the depletion of conventional fuels. Research on electric motor monitoring and speed-feedback techniques has also demonstrated the importance of effective motor control for improving electric-drive operation [3].

Ho *et al.* [5] investigated motor-drive and speed-control techniques for electric bicycles, demonstrating the significance of controlled motor operation for improved vehicle performance. Other studies considered charging infrastructure, bicycle-sharing applications, battery-supercapacitor energy-storage systems and charge-management strategies for electric bicycles. These studies collectively demonstrate that efficient motor control, energy-storage management, appropriate drivetrain design and user-friendly monitoring are important considerations in developing practical electric bicycles. The present work builds on these concepts by integrating electric propulsion, rider-controlled speed regulation and battery/speed monitoring into a conventional bicycle platform.

PROBLEM STATEMENT

Increasing transportation requirements and dependence on conventional fuels contribute to higher operating costs, depletion of non-renewable resources and environmental pollution. Although conventional bicycles provide an economical and pollution-free transportation option, continuous pedaling can result in rider fatigue and restrict their usefulness for longer journeys. Electric bicycles address this limitation, but practical issues including battery range, charging requirements, affordability, speed regulation and safe operation must be considered. Therefore, there is a need to develop an economical electric bicycle system capable of providing controlled electric assistance while retaining conventional pedal operation and providing the rider with information regarding vehicle speed and battery condition.

OBJECTIVES

The two main objectives of the proposed work are:

1. To design and implement an economical and environmentally friendly electric bicycle using a battery-powered PMDC motor while retaining conventional pedal operation.
2. To implement an effective speed-control and monitoring system that enables the rider to regulate bicycle speed and monitor important operating parameters such as speed and battery status.

The project report identifies the development of a battery- and motor-assisted electric bicycle as its primary objective and emphasizes economical and environmentally friendly transportation.

PROPOSED SYSTEM

The proposed electric bicycle integrates an electrical propulsion system with the mechanical arrangement of a conventional bicycle. The electrical system primarily consists of a rechargeable battery unit, PMDC motor, speed controller, throttle, power lock, battery controller and speedometer. Electrical energy stored in the battery is supplied to the PMDC motor through the speed controller. The throttle provides the rider's speed command, and the controller regulates the power supplied to the motor according to this input.

The system retains the conventional pedal mechanism so that the bicycle can continue to operate manually when electrical assistance is not required or when the battery charge is insufficient. A freewheel and chain arrangement mechanically transfer the motor torque to the wheel without significantly interfering with pedal operation. The combination of pedal and electric modes therefore improves operational flexibility and reduces rider fatigue during longer journeys.

BLOCK DIAGRAM

Fig. 1 shows the block diagram of the proposed electric bicycle speed control system, consisting of a power lock, speed controller, PMDC motor, throttle, battery unit, charging point, battery controller, and speedometer. The speed controller regulates the power supplied to the PMDC motor according to the throttle input, while the battery controller monitors the battery condition and provides the required information to the speedometer.

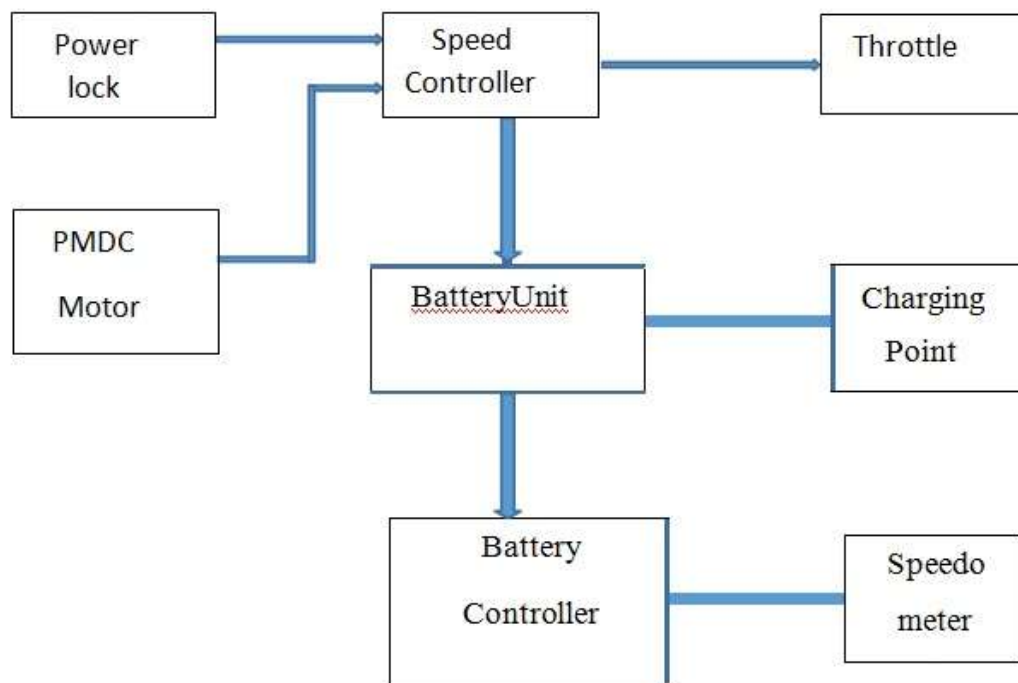


Fig.:1:Block Diagram of E-bicycle speed control system

CIRCUIT DIAGRAM

Fig. 2 shows the circuit diagram of the electric bicycle system, where the battery supplies power to the electrical bicycle controller through the battery connector and power switch. The controller interfaces with the motor, throttle, handle brake, LCD, and charging port to provide controlled motor operation, speed regulation, braking, and battery monitoring.

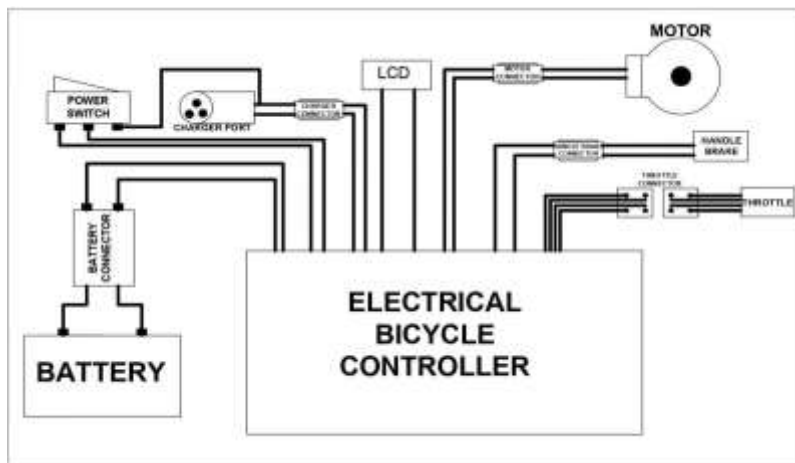


Fig.:2:Circuit Diagram of E-bicycle speed control system

METHODOLOGY

The methodology begins with the conversion of a conventional bicycle into an electrically assisted bicycle by integrating a PMDC motor and suitable mechanical drivetrain. The project uses a 250-W PMDC motor connected through a chain to an additional freewheel sprocket on the wheel axle. The motor is interfaced with the motor controller, battery unit and throttle. The mechanical arrangement is designed so that conventional pedal operation remains available when the electric drive is not used. The report also specifies an electronic braking arrangement intended to disconnect the motor supply when braking is applied.

During electric operation, the battery provides DC electrical power to the controller. The throttle acts as the rider's command input, and the controller regulates the power supplied to the PMDC motor. The controller employs PWM-based regulation to obtain smooth speed control. The motor subsequently develops torque and transfers mechanical power to the bicycle wheel through the drivetrain. The speedometer and battery-monitoring arrangement provide operating information to the rider. When battery-powered operation is unnecessary or unavailable, the bicycle can be operated using the conventional pedal drivetrain.

RESULTS AND DISCUSSION

The **Fig. 3** shows the developed electric bicycle was implemented and evaluated for charging time, vehicle speed and operating range. According to the experimental results reported in the project, the average battery charging time is approximately **3 h 15 min**, while the bicycle achieves a maximum road speed of approximately **30 km/h**. An economical riding speed of approximately **17–25 km/h** was observed for obtaining improved operating range.

The bicycle can travel approximately **45 km on a complete charge** under the reported operating conditions. The battery peak voltage is approximately **27 V**, whereas the motor excitation voltage is **24 V**. The individual cells are reported with a voltage rating of **3.2 V** and current-capacity rating of **2.6 Ah**. These results demonstrate that the developed system can provide useful electric assistance for short- and medium-distance transportation while allowing the rider to regulate vehicle speed according to operating requirements.

The implementation also demonstrates the practical advantage of combining conventional pedal propulsion with battery-powered operation. The rider can use pedal mode when electrical assistance is unnecessary and electric mode when reduced physical effort is preferred. The throttle-based controller provides convenient speed regulation, while speed and battery monitoring improve rider awareness during operation.



Fig:3 E-Bicycle

CONCLUSION

A battery-powered electric bicycle with speed-control and monitoring capabilities has been designed and implemented. The proposed system integrates a PMDC motor, motor controller, throttle, rechargeable battery, speedometer and mechanical drivetrain with a conventional bicycle. The dual-mode configuration enables the rider to select either conventional pedal operation or electric propulsion depending on travel requirements.

The implemented bicycle achieved a reported maximum speed of approximately 30 km/h and a travel range of up to 45 km per complete battery charge, with an average charging duration of approximately 3 h 15 min. The project demonstrates that electric bicycles can provide an economical and practical alternative for short- and medium-distance transportation while reducing rider effort. Future improvements in battery technology, motor efficiency, control techniques and integration with urban transportation infrastructure could further enhance the performance and usability of such electric bicycles. The source report similarly identifies electric bicycles as having considerable potential for sustainable future mobility.

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