Regenerative braking of Electric Bicycle using Battery-Supercapacitor System

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ABSTRACT

The development of sustainable transportation solutions has been fueled by growing environmental consciousness and energy concerns. As an environmental friendly, effective, and practical mode of transportation, electric bicycles, or e-bikes, have gained popularity as a viable substitute for traditional bicycles. However, a major obstacle to the general adoption of e-bikes is still their short range. Regenerative braking presents a viable method for increasing the range of e-bikes by converting the motion energy that is produced while braking into electrical energy. Traditional battery-based energy storage systems frequently have limitations in meeting the high-power demands of regenerative braking. Supercapacitors have become a very desirable alternative to batteries in e-bikes because of their remarkable power density and quick charge/discharge times. The feasibility of a hybrid energy storage system (HESS) for regenerative braking in e-bikes that combines batteries and supercapacitors is examined in this research. The high-power regenerative brake energy in the suggested HESS can be conveniently absorbed by the supercapacitor, and the gained energy may be stored in the battery for further use. [4] According to studies, the HESS effectively stores and uses regenerative braking energy, increasing the e-bike's range by up to 30% when compared to a battery-only setup. In addition, the HESS lessens the strain on the battery, which could increase its service life. The results highlight how supercapacitor-based HESS has the potential to completely transform e-bike technology by greatly increasing range and energy efficiency. This development could lead to e-bikes being more widely accepted as a viable and sustainable form of transportation, fostering a future that is greener and more ecologically sensitive.

KEYWORDS: *Battery, Supercapacitor, BLDC Hub motor, Buck-boost Converter, Bicycle.*

INTRODUCTION

The distinctive qualities of electric vehicles (EVs), such as their low emissions, high efficiency, silent operation, etc., are drawing more and more attention. Traffic jams cause more stop-and-go traffic, which burns more fuel and releases harmful pollutants into the air. As a result, electric mobility has been viewed as a futuristic mode of transportation that obviously reduces vehicle emissions. Since they are an effective and environmentally friendly form of urban transportation, electric bicycles have become increasingly popular. They have regenerative braking systems installed to increase their range and energy efficiency. This research describes a method for integrating a battery-supercapacitor system to provide regenerative braking on e-bikes. In electric automobiles, regenerative braking is a well-known technology that stores kinetic energy recovered during braking events for future use. We suggest a regenerative braking system that combines the use of a high-power density supercapacitor with a high-energy density battery.

A regenerative braking system will be designed to seamlessly transition between conventional mechanical braking and regenerative braking based on real-time conditions and rider inputs. When the rider applies the brakes, the system will engage regenerative braking to capture kinetic energy and store it in the hybrid energy storage system. Conventional regenerative braking