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Regenerative Braking System for Electric Vehicles

Prof. R. K. Nanwatkar[1], Mr. Krushna Mane[2], Mr. Mahesh More[3], Mr. Ajinkya Jagadale[4], Mr. Vyankatesh Joshi[5]

Assistant Professor, Mechanical Engineering, NBNSSOE, Pune, India[1]

UG Student, Mechanical Engineering, NBNSSOE, Pune, India[2,3,4,5]

Abstract: *In this project we are using this regenerative breaking concept to apply brakes to vehicle and creating electrical energy simultaneously by using alternator. Regenerative braking is an energy recovery mechanism that slows a vehicle or object by converting its kinetic energy into a form that can be either used immediately or stored until needed. In the project we are applying this concept to one wheel which is rotating. Its mechanical rotary energy is converted into the electrical energy. This electrical energy can be stored and utilized in critical situations or to run the internal components present in the car. To develop and design this project we are using CATIA V5 CAD software.*

Keywords: Energy, Stored, CATIA V5 CAD, etc.

I. INTRODUCTION

Regenerative braking is an energy recovery mechanism that slows a vehicle or object by converting its kinetic energy into a form that can be either used immediately or stored until needed. In the project we are applying this concept to one wheel which is rotating. Its mechanical rotary energy is converted into the electrical energy. This electrical energy can be stored and utilized in critical situations or to run the internal components present in the car.

II. LITERATURE SURVEY

1. Chengqun Qiua,, Guolin Wang, Mingyu Meng, Yujie Shen. "A novel control strategy of regenerative braking system for electric vehicles under safety critical driving situations" Volume 149, 15 April 2018, Pages 329-340 This paper mainly focuses on control strategy of the regenerative braking system of an electric vehicle under safety critical driving situations. With the aims of guaranteeing the electric vehicle stability in various types of tire-road adhesion conditions, based on the characteristics of an electrified powertrain, a novel control strategy of regenerative braking system is proposed for electric vehicles during anti-lock braking procedures. Firstly, the main construction of the case-study electric car with regenerative braking system is introduced. Next, based on the phase plane theory, the optimal brake torque is calculated for ABS control of an electric vehicle. Then, an allocation control, wherein the required optimal brake torque is divided into two parts that are disposed respectively by the friction and regenerative brakes, is discussed.
   In addition, two parameters for evaluating regeneration braking energy efficiency contribution while in the deceleration braking process are defined. Furthermore, a novel regenerative braking control strategy named "serial control strategy" is proposed. A regenerative braking system by electrically-controlled according to the techniques with conventional hydraulic ABS is studied, and a control algorithm harmonizing the ABS control functions and braking energy regeneration is developed. Three control strategies, namely, the "model following control," "frequency selection by filter," and PQ-method" strategies are developed. The optimal ABS control is anticipated on the electric motor responds much more fastly and precisely than the friction brake. Road tests verified the control performance of the developed method.

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2. Jiejunyi Liang, PaulD. Walker, Jiageng Ruan , Haitao Yang, Jinglai Wu, Nong Zhang. "Gearshift and brake distribution control for regenerative braking in electric vehicles with dual clutch transmission" Volume 133, March 2019, Pages 1-22To alleviate the problem of limited driving range per charge in electric vehicles, a dual clutch transmission based regenerative braking power-on shifting control system is pro- posed and investigated in this paper. Power-on shifting refers to the shift process where the power flow between the wheel and the power source is not cut offend could be maintained around a desirable value. This character is more important for regenerative braking than the normal driving conditions as the regenerative braking force from the motor accounts for a large part of the total braking force.
Due to the difference between the normal driving condition and the regenerative braking process, existing normal driving shifting control strategies, which could introduce significant torque interruption, cannot be directly applied for regenerative braking. As a result, the energy recovery capability and efficiency are compromised. To solve this problem, a power-on shifting control strategy for regenerative braking is proposed as well as an energy-safety oriented braking strategy.

3. Bla_z Luin, Stojan Petelin, Fouad Al-Mansour. "Microsimulation of electric vehicle energy consumption" Volume 174, 1 May 2019, Pages 24-32In this article it presents the Energy efficiency is among the main reasons for the increasing popularity of electric vehicles. Even though they are significantly more efficient in comparison to internal combustion powered vehicles, their efficiency varies. In the literature a significant gap between real world energy consumption and declared figures is noted. The paper includes a review of real-world energy consumption studies and measurements and identifies variables that affect it, such as vehicle drivetrain configuration, battery management systems, traffic and environmental conditions.
A simplified EV energy consumption model based on the VSP (Vehicle-Specific Power) is presented and evaluated on standard driving cycles, where it provided improvement over existing models due to the use of a charging power limiting function that better describes energy flow during braking energy regeneration. The model was also evaluated under diverse traffic conditions on trajectories obtained from traffic microsimulation using the SUMO (Simulation of Urban Mobility) model.

4. A. Joseph Godfrey, V. Sankaranarayanan, "A new electric braking system with energy regeneration for a BLDC motor driven electric vehicle" Volume 21, Issue 4, August 2018, Pages 704-713 In this article it presents, A new electric braking system is proposed for a brushless DC (BLDC) motor driven electric vehicle (EV) in this paper based on stopping time and energy regeneration. This new braking system is developed by combining various regenerative methods and plugging. Other than the existing performance measures such as boost ratio, braking torque, and maximum conversion ratio; stopping time and energy recovery for various methods are studied for different running conditions.
It is observed that the stopping time is less for plugging and increases in the order of two, three and single switch method. In addition, energy recovery is better for single and three switch method. Based on these performances, a new braking strategy is proposed which combine all the regenerative braking methods including plugging and switch among themselves based on the brake pedal depression. The effectiveness of the proposed method is shown using both simulation and experiment results.

III. IMPLEMENTATION

In this section we presented the making and working of Regenerative Braking System with some following points: Computer-aided design (CAD) is the use of computers to aid in the creation, modification, analysis, or optimization of a design. CAD software is used to increase the productivity of the designer, improve the quality of design, improve communications through documentation, and to create a database for manufacturing. CAD output is often in the form of electronic files for print, machining, or other manufacturing operations.

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CAD3DModel:

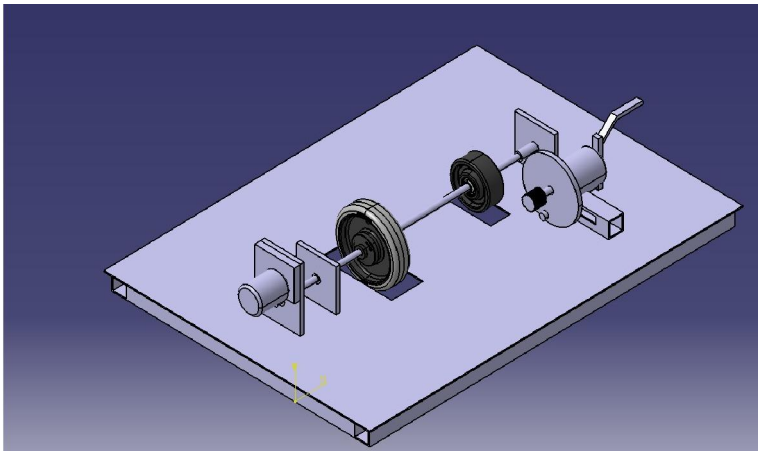

Figure: Conceptual 3D Model

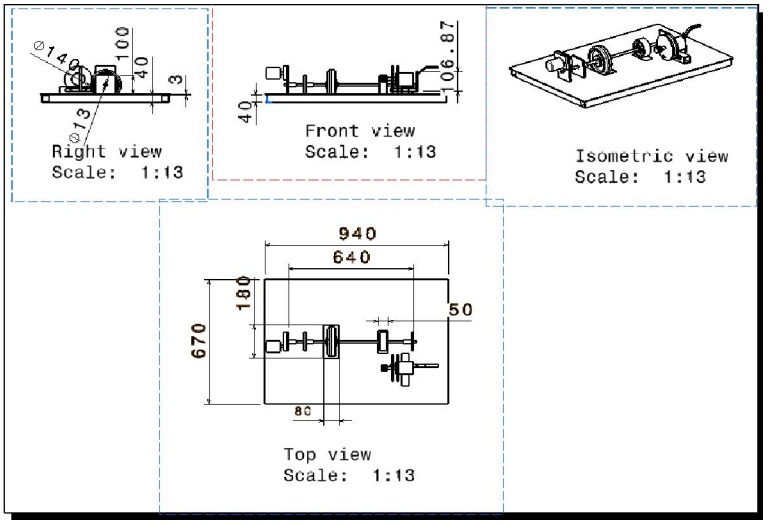

Figure: Drafting of the conceptual system

IV. RESULTS

Readings:

Time (min)	rpm	Current generated	
		Volt(V)	mAmp (I)
1	200	0.5	1000
2	500	2.8	1260
5	500	5.2	1400
15	500	6.2	1680
30	500	6.8	1850

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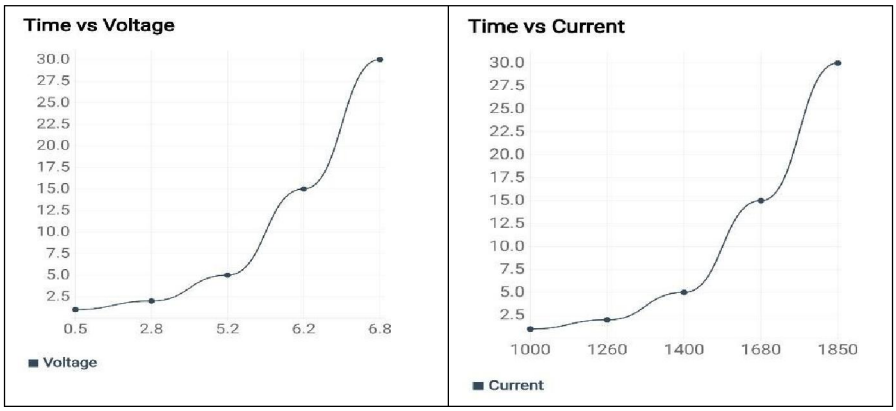

V. CONCLUSION AND DISCUSSION

The regenerative braking system used in the vehicles satisfies the purpose of saving a part of the energy lost during braking. The regenerative braking system is designed to partially recover the battery charge wasted in braking of the vehicle. The energy is converted into heat by friction brakes which are dissipated to the environment. This Energy is utilized to rotate the rotor of generator converting mechanical energy of wheels into useful charge of battery. The regenerative braking system cannot be used as main braking system of vehicle as it cannot bring the vehicle to rest.

Experimentally it is found that, on increasing the speed of the wheel (rpm) the voltage generated will also be increasing and vice-versa. As others researchers had used stepper or servo motors as regenerative motor, so in this project, it is replaced with D.C motor. Motor with gear. It has been found that the voltage generated by the D.C motor with gear is higher than that of voltage produced by those two motors. Hence, if this system is installed in the actual vehicles minimum 11% battery energy can be recovered using the regenerative braking system which would otherwise be wasted to heat in friction brakes. So the distance travelled between two successive charging requirements can be increase to 10 to 15 % using this regenerative braking.

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