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# Design of Electric Vehicle Drive Using Regenerative Power

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**ABSTRACT:** Electric Vehicles (EVs) and various Hybrid Electric Vehicles (HEVs) have been attracting a lot of attention for environmental issues and energy crisis. One of advantages of using foregoing vehicles is charging energy by the regenerative brake. The running distance by one electric charge is increased a lot by the regenerative brake. However, the absorbed capacity of the regenerative energy is limited because of the motor capacity and the current limit of the battery. This becomes serious issue in the heavy weight vehicle such as the bus and the truck, the effectiveness of EV/HEV is not obtained. The proposed method is experimentally evaluated by dynamo system, and increases the regenerative energy to 18%. Electric vehicles have a limited driving range compared to conventional vehicles. The main objective this project is to produce regenerative Power in Electric vehicle with improved efficiency.

**KEYWORDS:** Automation, E Vehicle, Regenerative Power

## I. INTRODUCTION

Prologue to Regenerative Braking Systems When a regular vehicle applies its brakes; motor vitality is changed over to warm as grinding between the brake cushions and wheels. This warmth is diverts in the airstream and the vitality is viably squandered the aggregate sum of vitality lost along these lines relies upon how frequently, how hard and for to what extent the brakes are applied. Regenerative slowing down alludes to a procedure in which a bit of the motor vitality of the vehicle is put away by a momentary stockpiling framework. Vitality regularly dispersed in the brakes is guided by a force transmission framework to the vitality store during deceleration. That vitality is held until required again by the vehicle, whereby it is changed over go into motor vitality and used to quicken the vehicle. The size of the part accessible for vitality stock piling changes as per the kind of capacity, drive train effectiveness, and drive cycle and idleness weight. A lorry on the mother way could travel 100 miles between stops. This speaks to small sparing regardless of whether the proficiency of the framework is 100%. Downtown area driving includes a lot additionally slowing down occasions speaking to an a lot higher vitality misfortune with more prominent likely investment funds. With transports, taxis, conveyance vans, etc there is much increasingly potential for economy.

Since regenerative slowing down outcomes in an expansion in vitality yield for a given vitality contribution to a vehicle, the effectiveness is improved the measure of work done by the motor of the vehicle is diminished, thusly decreasing the measure of prime vitality required to impel the vehicle. All together for a regenerative slowing mechanism to be practical the prime vitality spared over a predetermined lifetime must balance the underlying cost, size and weight punishments of the framework. The vitality stockpiling unit must be minimal, sturdy and equipped for dealing with high force levels productively, and any helper vitality move or vitality transformation hardware must be effective, minimized and of sensible expense.

The regenerative slowing mechanism (RBS) is a significant framework for vitality the board in HEV which can viably improve the cruising range. In this paper, EVT-HEV is taken as the exploration object and the proficiency advancement control methodology of RBS is contemplated. At present, the explores on RBS of the conventional HEV fundamentally incorporate basic plan, slowing down power dissemination control and composed control with different frameworks on vehicle. The structure of the regenerative slowing mechanism is regular in arrangement and equal structure. The creator contrasts the arrangement framework and the equal framework from the parts of regenerative slowing down proficiency and wellbeing. The investigates on slowing down power dissemination control mostly center around the appropriating pace of the mechanical and the regenerative slowing down power to accomplish the objectives of improving the ideal regenerative slowing down effectiveness, guarantee the dependability of the slowing down procedure, the slowing down solace and improving the presentation of the battery or the engine. A slip rate control methodology dependent on sliding mode control and a slowing down power control system dependent on ECE guidelines are proposed to improve the proficiency of regenerative slowing down. The fluffy control calculation is utilized to control the extent of regenerative slowing down power, so the slowing down power can be joined with the greatest slowing down power bend or make the control procedure of regenerative breaking progressively steady. Thinking about the battery life, regenerative slowing down productivity and wellbeing, the slowing down power conveyance strategy dependent on model prescient control is proposed. There are likewise different explores concentrating on the control system of regenerative slowing down engines. The explores on facilitated control with other vehicle frameworks are chiefly planned with the ABS, the transmission control, the guiding framework to guarantee the security of the vehicle and improve the working execution of the framework.

This investigate on RBS in EVT-HEV are principally remembered for the vitality the executives in EVT-HEV as a little part and a couple of explores are exclusively about the control methodology of RBS in EVT-HEV. While all the investigates on RBS in EVT-HEV are like the control methodology in the conventional HEV in which just one engine (the external engine) is used to give the regenerative slowing down power without thinking about the working province of ICE. EVT has various mechanical ports and electrical ports and the vitality transformation mode is more adaptable than power coupling system in the conventional HEV. The ebb and flow explores don't utilize the benefits of EVT and have the accompanying deficiencies:

- 1) When the vehicle is in half and half mode, the motor ought to be separated during the slowing down procedure along these lines all the vitality of the motor is squandered.
- 2) When the slowing down procedure is finished and the vehicle is in the state of cross breed mode, the motor should speed up to drive the vehicle subsequently the motor exchanging is visit.
- 3) When the vehicle is in unadulterated electric mode, the regenerative slowing down force is just given by one engine and the mechanical slowing down force supplements the insufficient slowing down force. In this way the regenerative slowing down vitality isn't completely recuperated.

In light of the issues existed in the flow explores on RBS in EVT-HEV, this paper exhaustively thinks about the working condition of the motor and EVT under different working modes, investigates the slowing down procedure of EVT-HEV in detail and proposes four distinctive slowing down modes including two respectable modes named as motor engine organizing slowing down mode (EMCB) and double engine slowing down mode (DMB). At that point a various leveled controller is proposed in which the standard based control procedure is utilized for slowing down mode exchanging and neural system calculation is utilized for the ideal productivity control for the framework. The exploration in this paper can bring another hypothetical establishment for the use of EVT in HEV and is of extraordinary essentialness to enhance the vitality the executives systems of HEV. The development purposes of our examination on RBS in EVT-HEV are recorded as following:

- 1) EMCB mode is right off the bat proposed in this paper and it can keep the motor working in the ideal state and the yield vitality can be transmitted into the battery during the regenerative slowing down procedure.
- 2) The motor isn't separated in EMCB mode, consequently when the slowing down procedure is finished, the motor can continue working in the ideal state and need not to switch the working state much of the time.
- 3) DMB mode is right off the bat proposed in this paper. With DMB mode, the internal engine is used to enhance the insufficient slowing down force. Along these lines, DMB mode can improve the vitality recuperation effectiveness.

## II. PROPOSED SYSTEM

The motor current, accelerating current is larger than the decelerating one because the limitation of the regenerative torque. During the regeneration period inverter is working as converter and it fed back the energy to battery. For the converter operation PWM is generated by Pic micro controller which is operated by 5v power supply.

### MODE-I

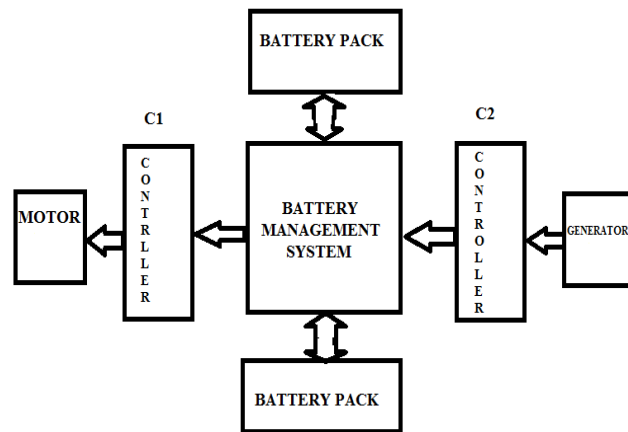


Fig 1. Block diagram of mode-1

### MODE-II

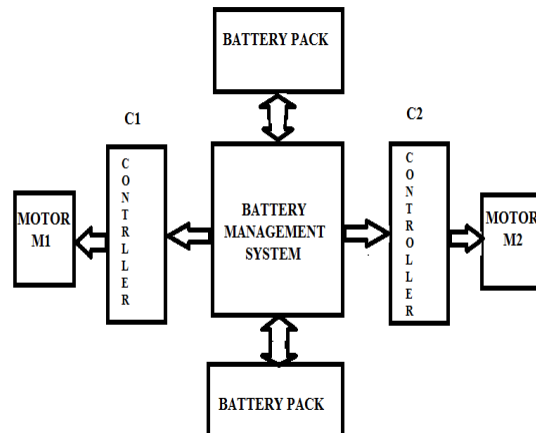


Fig 2. Block diagram of mode-2

Electric vehicles have a limited driving range compared to conventional vehicles. Accurate estimation of EV's range is therefore a significant need to eliminate that refers to drivers. To overcome this issue, more accurate range estimation techniques are being investigated.

#### A. Topology Structure of EVT-HEV

The topology structure of EVT-HEV is shown. The inner rotor of the inner motor (EM1) of EVT is connected to the output shaft of engine, and the outer rotor is connected to the final reduction drive as a common rotor of EM1 and the outer motor (EM2). The electromagnetic design, heat dissipation analysis and decoupling the engine and the road load

are decoupled by the rotational speed and torque control of EM1 and EM2. EM1 can adjust the engine to work in the optimal state and EM2 can be controlled to meet the road load requirement. Since EM1 and EM2 share the common external rotor, the magnetic field coupling between EM1 and EM2 exists in EVT. In recent years, many scholars have carried out extensive researches on the electromagnetic design, heat dissipation analysis and decoupling control of EVT which laid the foundation for the application of EVT in HEV and make the control of EVT is equivalent as the control for EM1 and EM2 separately. The equivalent split topology of EVT-HEV is shown. The operating mode of the EVT-HEV can be divided into the hybrid drive mode in which the engine is on and the pure electric mode in which the engine is off.

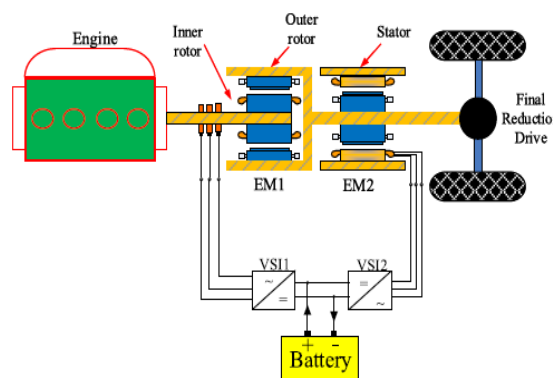


Fig.3. Structure of the separated EVT-HEV.

### B. Hybrid Drive Mode

The dynamic relationship and energy flow analysis of the hybrid drive mode are shown in Fig3.2. The engine output power is expressed as  $P_{ICE}$  which can be divided into two parts. One part of the energy expressed as  $P_d$  is transmitted through the magnetic field to drive the outer rotor and another part is transmitted into the battery with EM1 operating as generator which can be expressed as  $P_{EM1}$ . When the system is in steady state, the torque of engine expressed as  $T_{ICE}$  is equal to the electromagnetic torque of EM1 expressed as  $T_{EM1}$ . The speed of EM1 is the difference between the speed of engine and EM2. The external rotor of EM2 is connected to the final reduction drive whose speed is linearly relative to the velocity of the vehicle. The driving torque of the vehicle is equal to the resistance  $T_{LOAD}$  and consists of two parts. One part is  $T_{ICE}$  transmitted through the magnetic field of EM1 and another part is the torque of EM2 expressed as  $T_{EM2}$ .

Then the relationship between the engine and EVT is described as equation (1) in which  $I_{wheel}$  is the speed of wheel and  $single$  is the transmission ratio of final reduction drive,  $ICE$ ; EM1; EM2 is the speed of ICE, EM1 and EM2 separately and  $P_{EM2}$  is the power of EM2. When the vehicle demand power is equal to the engine output power, EVT-HEV system operates as the continuously variable transmission (CVT) and the energy for EM2 operating can be fully provided by  $P_{EM1}$ . When the vehicle demand power is larger than the engine's output power, EVT-HEV operates in the auxiliary drive mode in which the engine is still operating at the optimal operating point and the power flow is similar to CVT but the battery provides some power for EM2 to supplement the demand power. When the vehicle demand power is less than the engine output power, EVT-HEV operates in the generator mode when the engine operates at the optimal operating point and the excess energy is stored in the battery through EM1. In addition to the slight difference in power flow at the battery, the three drive models can be analyzed through the mathematical model described in equation.

### C. Mechanical Braking Mode (MB)

When the vehicle speed is low, the braking strength is emergency braking or SOC is higher than the maximum value, the efficiency and safety of regenerative braking process are poor. In this case the traditional mechanical brake (MB) is used for braking while EM1 and EM2 do not work and the power transmission between the engine and the road load is disconnected.

### D. Battery Charging Strategy

In a constant voltage charge, the charging voltage is maintained at the maximum voltage that should be applied to a certain type of battery while the charging current slowly decreases as the full battery charge is approached. This is an effective method when using lower voltages, as temperature usually isn't an issue, but lengthy charge times are of concern. As the name implies, this charging method applies a constant current as the battery voltage builds up to its full charge value. Even if the constant current applied is within the rated current, the constant current to the battery can easily cause overheating and damage, compromising the life of the battery. Originally referred to as simply "Voltage Controlled Charging", constant current-constant voltage charging is a common approach to battery charging where the charger applies a constant current until the battery reaches a predefined voltage potential, at which point voltage is held constant and the current continues to decrease until a full charge is reached. This is illustrated in Figure 4.1. And is the traditional method for charging batteries, yet it is limited in fast-charging applications because battery polarization becomes an issue. As may be expected, the CC-CV method has been further modified to include multiple constant current steps, thereby further improving the rate of charging of the batteries.

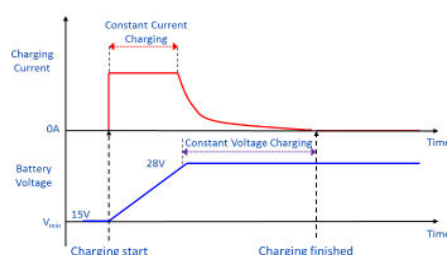


Fig.5. Constant Current-Constant Voltage Battery Charging

## III. RESULT AND DISCUSSION

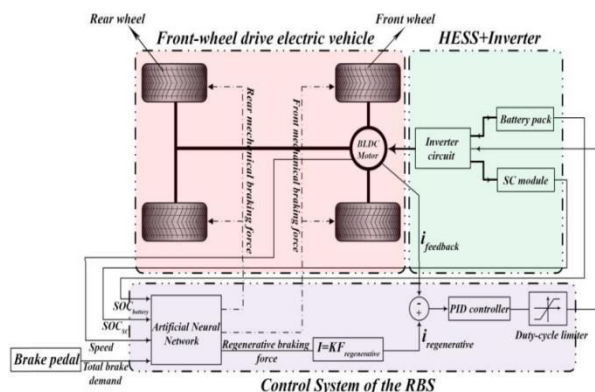


Fig.6. Structure of the control system of the proposed regenerative braking method

## IV. CONCLUSION

In this paper, a new RBS based on utilization of HESS is proposed for EVs driven by BLDC motor. During regenerative braking and/or energy regeneration, the kinetic energy of the vehicle is harvested by the super capacitor using appropriate switching template of the inverter. Hence, the need to additional power electronics interfaces is eliminated. Moreover, the PI controller is used to control the duty cycle of the PWM in the inverter to realize constant torque braking. In comparison with other similar types of the regenerative braking schemes, the proposed method has the superiorities of being simple and being high-efficient. Regenerative braking with ESS, the efficiency of the regeneration is improved about 20%. Moreover, it is shown that the drive range of the EV is increased about 5 cycles. It can be concluded that the presented scheme is able to capture the braking energy with appropriate efficiency and ensures the safe deceleration of the EV.



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