REGENERATIVE BRAKING SYSTEM OF BLDC MOTOR WITH AUTOMATIC BRAKING AND BRAKE FAIL DETECTION FOR ELECTRICAL VEHICLE

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Abstract: **Today, machines are widely controlled by automated control system. To meet the need of growing population economic, effective and reliable control of machines as well as their control system is necessary. Energy saving has become an important factor. So it is necessary to reduce the energy loss. For this the regenerative braking plays an vital part to maintain the vehicle's strength and getting better energy. Now-a-days accidents are mostly caused by delay of the driver to hit the brake or due to failure of brakes. For this we are focusing on automatic breaking system which will be operated with the help of sensor an will detect the obstacle. Apart from that the brake fail detection using sensor is also included in our paper.**

Index Terms – **BLDC motor controlling and braking, obstacle sensing, Brake fail sensing.**

I. INTRODUCTION

I.   Now-a-days combustion fuel is major problem which affect our environment. to avoid this problem electrical vehicle is the one alternative of combustion vehicles. For these vehicles are run used electric motors of either AC or DC. DC motors are mainly used for batteries are used for drives itself.In current circumstance, in view of the progression in power electronic converters, motors, for example, brushless (BLDC) motors, perpetual magnet synchronous motors (PMSM) are in pattern. In any case, from these, BLDC motors are for the most part utilized because of high effectiveness, huge beginning torque, high force thickness, quiet activity, low weight and littler in size. most recent vehicles are controlled by center sort BLDC motors, motors in-work in the wheel, to stay away from complex component.[1]

II.   Important parameter in electrical vehicle is the range i.e. the distance traveled by the vehicle per charge, Improving the range is the primary target for a large portion of the producer of electrical vehicle. The range can be improved by expanding the battery limit or expanding proficiency of the all segments including the engine, power converter. Regenerative braking is one of the techniques to expand the battery reinforcement by charging the battery from the vitality accessible during braking period. During regenerative braking, the vehicle kinetic energy with power electronic converters makes the motor as the generator to send the power back to the battery effectively. Studies are guarantee that the driving reach can be improved by 8–25% utilizing regenerative braking innovation. [1]

III.   Presently a days, the quantity of vehicles builds everyday. With increment in vehicles increment in accident. These accidents are generally caused because of the trouble making of driver or postponement of the driver to apply the brakes. These accidents are mostly caused due to delay of the driver to apply the brakes. To forestall the accidents brought about by this deferral, we give ultrasonic sensor framework in automobiles. By utilizing this sensor on the off chance that impediment draws close to the vehicle, at that point this senor work and giving braking to the vehicle and this braking is likewise work with regenerative activity. This framework incorporates ultrasonic sensors viz. one ultrasonic wave producer and one ultrasonic wave recipient. The producer is put at the front side of the vehicle which sending the ultrasonic rays and collector set other than the producer gets the rays when there is any article before ultrasonic sensor .This data By utilizing this sensor on the off chance that impediment draws close to the vehicle, at that point this senor work and giving braking to the vehicle and this braking is likewise work with regenerative activity.is given to the controller. In controller the reflected wave (identification beat) is estimated to get the separation among vehicle and the hindrance. Hence, this new framework is structured with the end goal that it can take care of the issue where drivers will most likely be unable to brake physically precisely at the necessary time, yet the vehicle can in any case stop consequently by detecting the obstacle to maintain a safe distance from a accident. [2]

IV.   Also accident are happen because of numerous reasons, the one of the primary explanation is brake disappointment, it caused to because of item deformity just as poor support, so as to forestall mishap the brake bomb discovery framework is significant thing in car. This is equipped by sensors and auxiliary braking unit. The braking rod of vehicle is generally fixed with small movement. This behavior of braking rod used for brake fail detection. If brake get breaking down then braking rod takes large movement which sensed by sensor which placed near to the rod. This sensor gives the indication before starting the vehicle.[3]
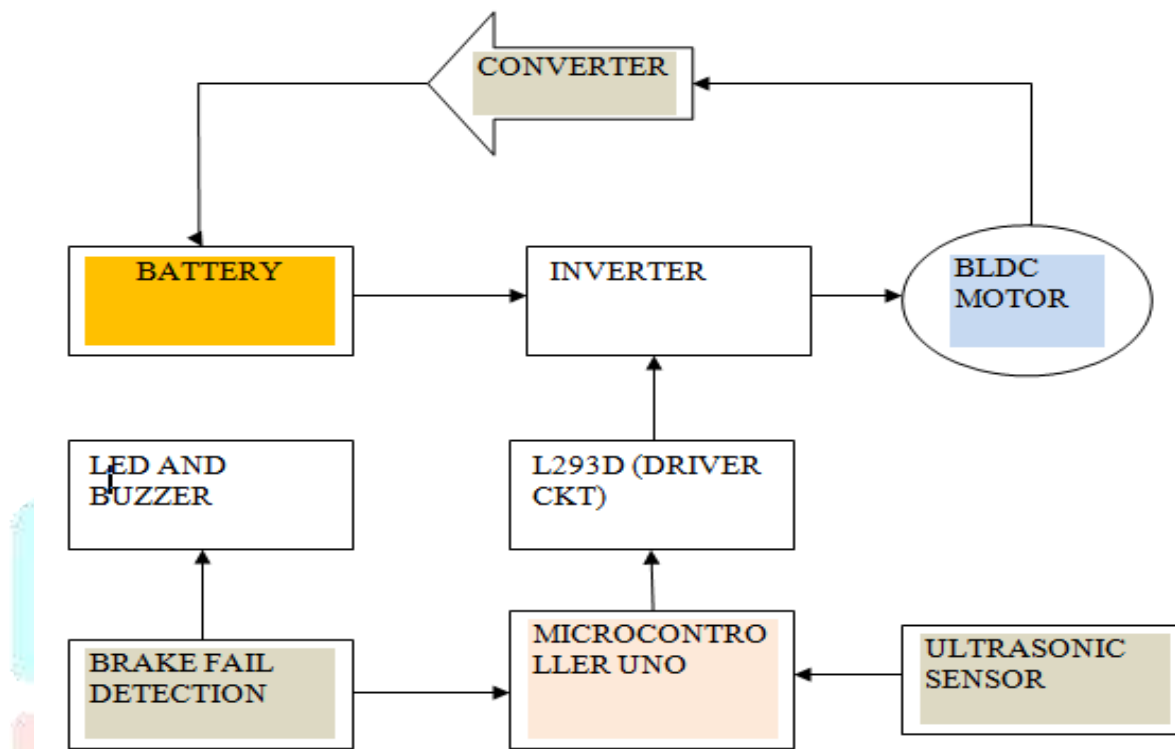
II. BLOCK DIAGRAM:-

Fig 1. Block diagram
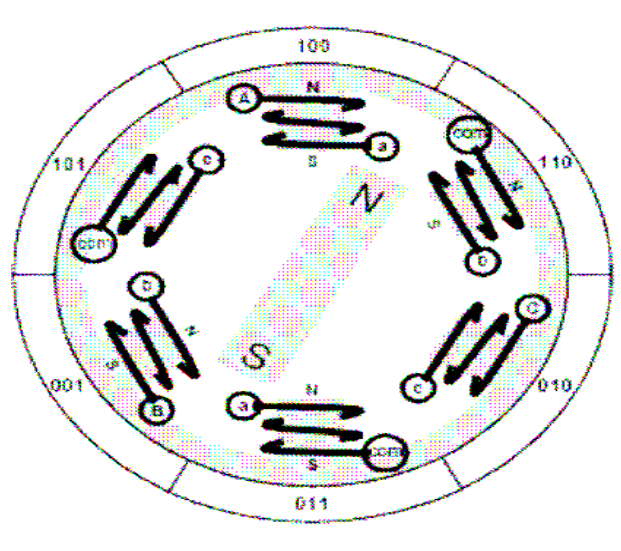
III. THEORY:-

a. BLDC MOTOR-

Fig. 2. Permanent Magnet BLDC Construction

Brushless DC motors are preferably reasonable for electrical vehicles in light of their high proficiency, great speed-torque qualities, wide speed extend, low maintenance, high power density. This motor is type of synchronous motor. It implies magnetic field produced by the rotor turn and magnetic field created by the stator at same recurrence. BLDC motors don't encounter the slip. Which is ordinarily found in the induction motor. In development of BLDC motor perpetual magnets are set on rotor. Armature winding is put on the stator of BLDC motor. A BLDC motor requires complex gadgets for control. At motoring mode motor expend the force from battery and at during braking mode it go about as a generator and charge the battery
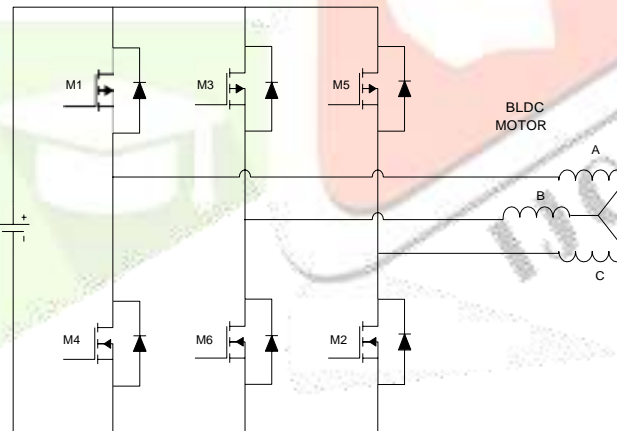
b. BLDC MOTOR CONTROL-

Fig.3 Power Inverter Circuit

The rotation of BLDC motor control is the main control using electronic commutator (inverter).And commutation is achieved by the energizing opposite pairs of pole in sequential manner. Multi level H-Bridge inverter is used for the controlling.. For controlling the BLDC motor, position of rotor is essential, on the basis of rotor position commutation is determine. To know the position of rotor hall effect sensor are used. Each motor lead is connected to the high side and low side switches. Voltage vector of motor is divided in six sectors. At time of regenerative braking all three phase winding will produce back EMF. A number of switching devices can be used in the inverter circuit but mostly MOSFET and IGBT controlling circuit are used, in this paper MOSFET are used due to low output impedance.

1. REGENERATIVE BRAKING:-

Regenerative braking can be achieve by reversing thecurrent flow from motor to battery at the time of deceleration by applying appropriate switching. Taking advantage of motor act as a generator redirecting the flow of current to charge the battery. The same power circuit shown in fig(2) can be used with appropriate switching strategy at time of deceleration. One of the most simple and efficient method is independent switching in conjunction with pulse-width modulation (PWM) to implement an effective braking control. In independent switching, all electronic switching devices are turn off at time of regenerative braking. PWM is used to control the level of regenerative braking by varying the duty cycle of the PWM.

Figure 4 shows the current flow path during coasting, during which there is no current ex- change between the BLDC and the battery.[4]
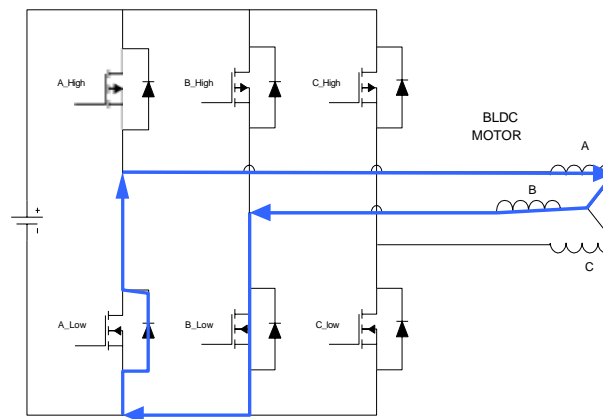

Fig. 4. Coasting Current Flow for First Commutation

In coasting mode, the energized windings of the motor allow the current to flow through the low-side of the PWM switch and through the freewheeling diode of the low-side high phase switch. Thus no amount current flows from the BLDC machine to the supply battery. During regenerative braking period current in the winding is reversed and supplied back into the battery. In this mode, all switches are turned off and the current can flow back through the free- wheeling diodes connected across MOSFET.

2. AUTOMATIC BRAKING:-

For automatic braking we can use ultrasonic sensor. This ultrasonic sensor interfaced with Arduino UNO. An ultrasonic sensor consists one transmitter and one receiver to communicates signal between them. Microcontroller providing triggering electrical pulse to the ultrasonic sensor which produces ultrasonic waves (echo pulse) and transmit through the transmitter. If there is no obstacle then the transmitted waves goes continuously towards forward side. If any obstacle comes near to the sensor then transmitted signal reflect back from obstacle and this reflected signal receives by receiver which is part of ultrasonic sensor. Received signal in form of sound waves. This sound waves convert into the electrical signal at ultrasonic sensor and gives to the microcontroller. This electrical signal is processed in microcontroller to measure distance between obstacle and sensor. Distance calculating program into the microcontroller is basis on time required after sending the waves to receiving the waves by sensor with consideration of velocity of sound. The measured distance canbe used for the calculationto produce an audio- visual warning as well as to trigger automatic control outputs for automatic brakes depending on the threshold parameters set according to the software program.

The block diagram is shown in Fig.1. The system consist of Power supply unit (a DC battery which can supply upto12v and the circuit takes up7-12V and supplies 5VDC to the microcontroller), sensors and other Output devices, range sensing unit for distance measurement, warning unit-consisting of Buzzer , LCD display to provide warning signals to driver of vehicle or road users and braking unit for braking purposes. The Power Supply Unit- In this project used 12Vdc battery for drives the all circuits But microcontroller and ultrasonic sensor used 5VDC to operate itself, therefore there used voltage regulator which supply constant 5VDC.

Range Detecting Unit-

For range detecting unit used. HC-SR04 ultrasonic sensor which works on sonar to calculate the distance. HC-SR04 having stable output, excellent range accuracy and it is easy to use. Its operation does not affected by sunlight or darkness. It can be measure distance between 3cm to 400cm. The Microcontroller selection- The control subsystem consists of the Arduino circuitry controlled by a program loaded in its memory. The Arduino circuitry consists of an Atmega 328p microcontroller chip, a 16 MHz crystal oscillator, two 22 pF capacitors and a reset button. The 16 MHz crystal is used for   timing; the reset button is used to reset the microcontroller to upload new program or to start running the existing program from the beginning.
Wire connection for the ultrasonic sensor modules is described as:

- VCC is connected to 5VSupply
- Trig ,which is Trigger Pulse Input is connected to microcontroller digital input/output pin.
- Echo which is Echo Pulse Output is connected to microcontroller digital input/output pin.
- GND is connected to 0VGround.

3. BRAKE FAIL DETECTION:-

For brake fail detection system used IR sensor which detect the braking rod which placed at front of the sensor. If brakes of vehicle get damaged then rod get down from front of sensor and sensor gives give signal to the microcontroller. Microcontroller turns ON the buzzer which indicates brake failure in vehicle.

IR sensor unit-

IR sensor unit consist one transmitter and one receiver circuit which driven by 12VDC supply. Transmitter transmit the infrared signal and this signals reflect back from braking rod and receives this signal by receiver. The circuit diagram of transmitter and reciever circuit as shown in fig.
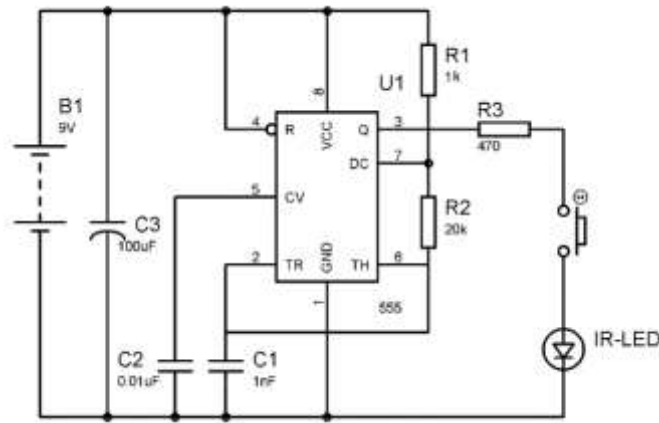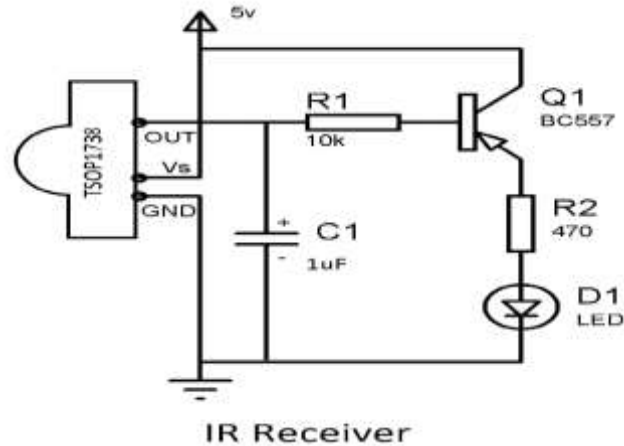
Figure 5: IR Transmitter Circuit Diagram

Figure 6: IR Receiver Circuit Diagram

Buzzer –

     A beeper or a buzzer is an audio signal device which can either run in mechanical, a piezoelectric. They are normally used in alarm devices, timers and in computers and laptops while pressing of wrong keys.

Integrated circuit –

     For brake fail detection used microcontroller arduino UNO which interfaced with IR sensor. Its operation is controlled by program. Arduino circuitry consists of an ATMEGA 328p microcontroller chip, a 16 MHz crystal oscillator, two 22 pF capacitors and a reset button. The 16 MHz crystal is used for timing; the reset button is used to reset the microcontroller to upload a new program or to start running the existing program from the beginning

3.1 AT BRAKING CONDITION:

     The IR transmitter sensor transmits the infrared rays. The IR receiver sensor receives the IR rays from the obstacle. In normal condition receiver receives the signal from obstacle. So microcontroller program keeps the buzzer input at low. Therefore buzzer remains in OFF condition.

3.2 AT BRAKE FAILURE CONDITION:

     In this condition braking rod moves from front of the sensor. Transmitted signal goes continuously towards forward side and receiver cannot receive the signal. So the microcontroller program turns ON the buzzer which indicates the brake failed.

CONCLUSION

     The regenerative braking, auto-braking and brake fail detection is explained in above information .This information gives the idea about the concept for practically implementation. This concept provides cost effective braking system of vehicle.

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