Battery/Ultracapacitor Hybrid Energy Storage System for Electric, Hybrid and Plug-In Hybrid Electric Vehicles

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Abstract: In this paper, battery/ultracapacitor hybrid energy storage system (HESS) is proposed for electric vehicles, it is used to large dc-dc converter by using ultra capacitor and battery. It is also use the dc link for the purpose of maintain the peak voltage value. By the help of battery and ultracapacitor they are operate. The battery is used to charging the capacitor in case of discharge the capacitor. In this case battery is working. It is also used to the regenerating breaking to store that energy in case of vehicles stoppage the energy will be loss. The battery life time increase by using ultra capacitor. In case of ultracapacitor working, the battery will isolated with power supply. This experiment is done successfully and verified output of proposed system.

Keywords: Battery • Control • Dc/dc converters • Electric vehicles • Energy storage • Hybrid electric vehicles (HEVs) • Plug-in vehicles • Power electronics • Propulsion systems • Ultracapacitor (UC)

INTRODUCTION

ENERGY storage systems (ESSs) is very important in electric vehicles. Batteries is one of the major source of energy in case of large voltage supply very difficult to arrange the battery power. This problem is solved by using the ultracapacitor. This energy is combined form of battery and ultracapacitor as hybrid energy. It is more than ten times decrease the size of the battery. It is used for compatibility and reduces the size of the battery.

In order to solve the problems listed previously, hybrid energy storage systems have been proposed. The basic idea of an hybrid energy storage system is to combine ultracapacitors and batteries to achieve a better overall performance. This is because, compared to batteries, UCs have a high power density, but a lower energy density. This combination inherently offers better performance in comparison to the use of either of them alone.

In the most widely used conventional HESS designs, the battery pack is directly connected to the dc link while a half-bridge converter is placed between the UC bank and the dc link. To solve all these aforementioned problems, a new HESS is proposed in this paper [1].

Advance Energy Storage System: The battery is electrochemical device. It is high energy and low density function. Ultracapacitor has low energy and high density function. The life time of battery is very less in compare to Ultracapacitor life and Ultracapacitor having more lifetime.

The Passive element connection in Parallel: The passive element ultracapacitor in battery are combining together. It is shown that the voltage of battery and ultracapacitor is same then behaves like a low pass filter.

The voltage increased by the help of ultracapacitor, battery and dc-dc converter.

In Fig 1 indicate that the supply voltage is given by battery and voltage increased by the help of ultracapacitor then given to the driver circuit and load.

In Figure 2 indicate that the supply voltage is directly given by ultracapacitor is high. It is given to the dc-dc converter. In case of ultracapacitor will discharge then battery is working. Again capacitor will charge then battery is stop the working and capacitor is given the supply in inverter and battery.

In Figure 3 is indicate that the battery voltage is increased by dc-dc converter then it will increase the voltage after that increasing in the voltage by using the

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In Figure 4 it is indicated that the supply is given by the battery voltage, which is increased by the dc-dc converter. Then voltage again increases by the ultracapacitor. The voltage is increased or constant whatever it requires. It is maintained by the dc-dc converter. Then the supply is given to the inverter and motor as a load.

In the Figure 5, it indicates that the voltage supply is given by the parallel connection because in the case of any fault in the previous circuit, it will not work. But in the parallel connection, any fault in the one circuit then the supply is given by the other parallel connection. The working is the same as the previous circuit. But here, the advantage is parallel connection and it will work properly at the time of one circuit fault.

In this figure, it indicates that the supply is given by the battery and capacitor in a single dc-dc converter. The voltage range required high then apply is given by the ultracapacitor when the voltage range is required less, then supply is given by the battery directly. After that, the dc-dc converter increases the voltage, that voltage is supplied to the inverter. Before inverter using the dc link, it will maintain the peak voltage and fluctuation of voltage wave form [2].

**Energy Storage System:** The selection of voltage storage system or energy storage component. The characteristics of battery like the storage capacity is high but the power density is low and it also stores time is more. It will increase the size when the voltage range will increase. The size of battery is the biggest problem to carry from one place to another place. And also using the vehicles and any starting device.

The characteristics of ultracapacitor are the power density is very high but the storage capacity is negligible. But the combination of an ultracapacitor, the voltage increases and size will also decrease. The cost of high voltage battery is very high but the combination of low voltage battery is very low.
voltage battery and ultracapacitor to produce high voltage. By combining of both the cost of source very decreases.

After increasing the voltage using the dc link it will maintain the peak voltage and fluctuation the wave form.

**Safety of Battery:** It is very important to increase the life time of the battery and fully use the energy. By using the ultracapacitor it will help the increase the speed of vehicles and also the working time of the battery is very less because the maximum time capacitor is working. It is also very important to store the energy at the timing of stopping the vehicles. When vehicles is stopping that time some distance will cover for using the regenerative braking process. It will store the energy by regenerative braking, in that time the motor is behaves like a generator.

**Total Cost Of Project:** Compare to existing system it is less cost and smaller size operating characteristics like speed is very good because the existing system the conventional battery is used. The conventional battery of voltage range depend upon size of the battery [3].

Using the ultracapacitor and battery the power density, energy density and efficiency will increases. Also Overall cost is less.

The management of battery and cost is very important because it is directly proportional to the cost of the project and also efficiency. Weight of vehicles is increases then efficiency is decreases and also cost increases.

**Proposed of Hybrid Energy Stored System**

**Overall View:** The conventional capacitor and dc-dc converter is not get proper peak power demand. The capacity of capacitor is very less than ultracapacitor. By using ultracapacitor and battery easy to get peak power. It is controlled by dc link [4].

Fig. 7 is shown the simulation battery power. It is first introduced in united states by applying driving cycle. The first time cycle was running 12km and direct stop. Then maximum speed is get 91 km per hours and average speed 31 km per hour. By removing the stop condition and increasing the speed. It is using the combination of battery and ultracapacitor. It is shown in figure 8.

The charging and discharging process is increase by using ultracapacitor. According to simulation find the average speed and peak power. It is very good compare to existing system.

The difference between peak and average power. Consider a water cane and mug. The energy density of water cane is very high but power density is less but in a mug the energy density is less but power density is high. For example like discharging the water. The mug will rapidly discharge with compare to water cane. The average value is water cane and peak value is mug. Based on the average concept design the system in Fig 8. The battery is connected to dc-dc converter. And it is also connected to diode or any controlling switch and bi directional dc- dc converter connected to the ultracapacitor. The battery voltage is increased by dc-dc converter. It is directly charging the ultracapacitor [5].

In the operation of vehicles the supply separately depending upon battery and ultracapacitor. After that the supply given to the dc -dc converter. In the power supply depend upon the battery and ultracapacitor supply, the driving of vehicles depend upon changing the power supply.

The voltage range of the battery is less than capacitor. Then supply is given by the ultracapacitor. It is high voltage operation but in the case of ultracapacitor will discharge then supply given by battery and also charging the capacitor. It will operating as boost converter.
Mode I: Vehicle Low consistent speed operation

In this case the battery voltage is greater than ultracapacitor voltage. The battery voltage supply going to diode. After that it will go to load. In same time capacitor will charge. The supply is going inductor and diode is forward to main supply. it is charging the capacitor and also supply is going to dc link. Dc link is easy to control the peak value because the voltage range is less.

Mode II: High consistent speed operation

The battery supply directly given to the diode or any controlling switching device. The supply is directly given to the inverter. In this case the capacitor will not charging and discharging. And dc-dc converter is also not working. The voltage supply is greater than previous circuit. In the previous circuit the voltage is distribute two part. One is for charging purpose of capacitor and another is given for the driving the load.

Mode III: Acceleration

Deceleration mode operation motor behaves like a generator. It will give the supply when vehicles will stop the given supply, but running vehicle will not stop at a
time. In this case only motor behaves like a generator. The
generator supply directly given to the capacitor and
capacitor will charge. It is generally low speed operation.
There is no dc-dc operation happened.

In this case the generator supply is given to the
boost converter. After that it will again charging the
battery the process is only happened when ultracapacitor
is charge. The dc-dc converter behaves as a bulk
converter [7].

CONCLUSION

This is a new project in compare to existing
system. This project is fully based on battery and
ultracapacitor. There is no need to matching the supply.
In this project used fully dc-dc converter. In case of
ultracapacitor will discharge the voltage then the voltage
range will be less than battery voltage, after that battery
is working.

In this project the battery use very less generally
capacitor is working, that’s why the lifetime of the battery
will increase. It is also reducing the challenge of the
battery range.

The proposed system is very small size compare to
existing system. Also this project having cost is very less
in compare to existing system and scope is more.

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