SUPERCAPACITOR AND BATTERY POWER MANAGEMENT IN ELECTRIC VEHICLE APPLICATION

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ABSTRACT

This paper presents on application of supercapacitor and battery power management in electrical vehicle. In the last few years the pollution problems and the increase of the cost of fossil energy (oil, gas) have become planetary problems. The car manufacturers started to react to the urban pollution problems in nineties by commercializing the electric vehicle. But the battery weight and cost problems were not solved. Battery power request in transient state decreases its life span. To solve this problem, the battery and supercapacitor (SCAP) hybridization, there must be good energy management between these devices which enables the reduction of the battery size and improves its life span.

This paper presents supercapacitor (SCAP) and battery modelling with an original energy management strategy in a hybrid storage technology. The studied dc power supply is composed of SCAPs and batteries. SCAPs are dimensioned for peak power requirement, and batteries provide the power in steady state. In this paper we are going to concentrate on various parameters of supercapacitor. A IOT Controller used for the digital meter which shows the speed of motor and battery level also. Batteries are directly connected to the dc bus. The originality of this study is focused on SCAP behaviour modelling and energy management strategy.

In electric vehicle applications of super capacitor have been reviewed in detail. It was found that the vehicle using supercapacitors had the better performance than those using the batteries and in general more efficient. In addition, there is a good possibility that the life of the capacitors would be equal to that of the electric vehicle. By using this combination, the overall characteristic of battery is improved and the performance of battery is improved.

Keyword: - *Supercapacitor(SCAP), Ride through, Battery, and Power Management etc….*

1. INTRODUCTION

In the last few years the pollution problems and the increase of the cost of fossil energy (oil, gas) have become planetary problems. The car manufacturers started to react to the urban pollution problems in nineties by commercializing the electric vehicle. But the battery weight and cost problems were not solved. The batteries must provide energy and peaks power during the transient states. These conditions are severe for the batteries. To decrease these severe conditions, the super capacitors and batteries associate with a good power management present a promising solution.

The difference between lead acid battery, conventional capacitor and super capacitors are listed in table 1. [1] With such advantage of supercapacitors over other conventional capacitor and battery the combined working or individual working of it is of main interest. The supercapacitors are mainly used in ride through condition. Ride through condition means the requirement of large amount of power for the short time duration. For the few second of time we can use supercapacitors [1].

Supercapacitors are storage devices which enable to supply the peaks of power to electrical vehicle during the transient states. During the steady states, batteries will provide the energy requested [2]. This methodology enables to decrease the weight and increases the lifespan of the batteries.

Table -1: Comparison of Battery and Supercapacitor

Available performance	Lead acid battery	Conventional capacitor	Supercapacitor
Charge time	1 to 5 hrs	10-3 to 10-6 sec	0.3-30 sec
Energy (Wh/Kg)	10 to 100	<0.1	1 to 10
Life cycle	<1000	>500000	>5000
Charge/discharge efficiency	0.7 - 0.85	>0.95	0.85 – 0.98
Power density	<1000	<100000	<10000

2. LITERATURE REVIEW

In this paper [1] Introduced combined working of supercapacitor &battery using MATLAB Simulink & basic hardware. In conclusion Supercapacitor & battery together as well as individual improve system performance. Our finding from that paper is that we Got an idea about supercapacitor used during ride through condition. Ride through condition means the requirement of large amount of power for the short time duration. For the few second of time we can use Supercapacitor [1].

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In this paper detailed information about Supercapacitor and batteries are given. Conclusion from that paper is supercapacitor overcomes the batteries soon. Replacement of batteries by super capacitor because of their inherent high power capacity & long charge/discharge cycle is discussed [3].

From this paper we studied Supercapacitor & their application in electrical vehicle in place or in combination of batteries which is given in that paper. In result Vehicles using the SCAP had better performance than those using batteries. Also test data are shown for hybrid supercapacitor [4].

2. CONSTRUCTION

The paper consists of three main components Supercapacitor, Controller and battery.

2.1 Supercapacitors

A Supercapacitor (SC), also called an ultra-capacitor, is a high capacity capacitor with a capacitance value much higher than other capacitors, but with lower voltage limits, that bridges the gap between electrolytic capacitors and rechargeable batteries. It typically stores 10 to 100 times more energy per unit volume or mass than electrolytic capacitors, can accept and deliver charge much faster than batteries, and tolerates many more charge and discharge cycles than rechargeable batteries [3].

A Supercapacitor, like all capacitors, stores potential energy electrostatically. This is what allows the capacitor to rapidly deliver and accept a charge, in addition to tolerating exponentially more charge cycles. There is no chemical reaction that takes place; however, Supercapacitor differ from standard capacitors, as instead of using a conventional dielectric between charged plates they operate off of electrostatic double layer capacitance (EDLC) and electrochemical pseudo-capacitance technology [3].

Fig -1: Supercapacitor

2.2 Node MCU ESP-8266 (Controller):

ESP8266 is a Wi-Fi SOC (system on a chip) produced by Espressif Systems . It is an highly integrated chip designed to provide full internet connectivity in a small package. ESP8266 can be used as an external Wi-Fi module, using the standard AT Command Set Firmware by connecting it to any microcontroller using the serial UART, or directly serve as a Wi-Fi enabled micro controller, by programming a new firmware using the provided SDK. Node MCU uses Lua Scripting language and is an open source Internet of Things (IoT) platform.

This module comes with a built in USB connector and a rich assortment of pinouts. With a micro USB cable, you can connect NodeMCU devkit to your laptop and flash it without any trouble, just like Arduino. It is also immediately breadboard friendly.

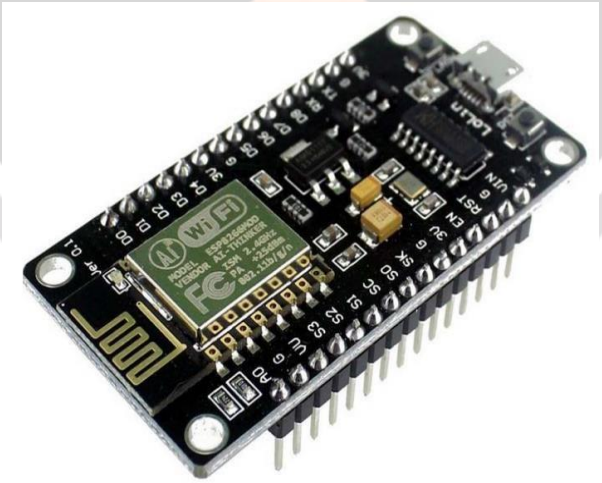


Fig -2: Node MCU ESP-8266 (IoT Controller)

2.3 Battery:

A 12-Volt,7 Ah lead-acid battery is preferred and used. Main reason of using such lead acid battery is its availability and comparatively cheaper cost. Two lead acid batteries are connected in series to double the voltage. An average 12 volts 7 Ah capacity Lead-acid battery (car battery) should supply about 90Wh, provided that the energy withdrawal is at low level current.

Fig-3: Lead-Acid Battery

3. WORKING

3.1 Proposed Work

At the start weight of the vehicle is more because of that no momentum and this is the time when vehicle consume more power to launch the vehicle from starting stage. At the starting vehicle requires more torque & constant current which is not possible in battery for that purpose supercapacitor is used at the initial level to launch the vehicle from start to speed up to 20 to 25 km/hr. After reaching speed up to 25 km the charge controller stops current from supercapacitor and starts battery current to run the vehicle.

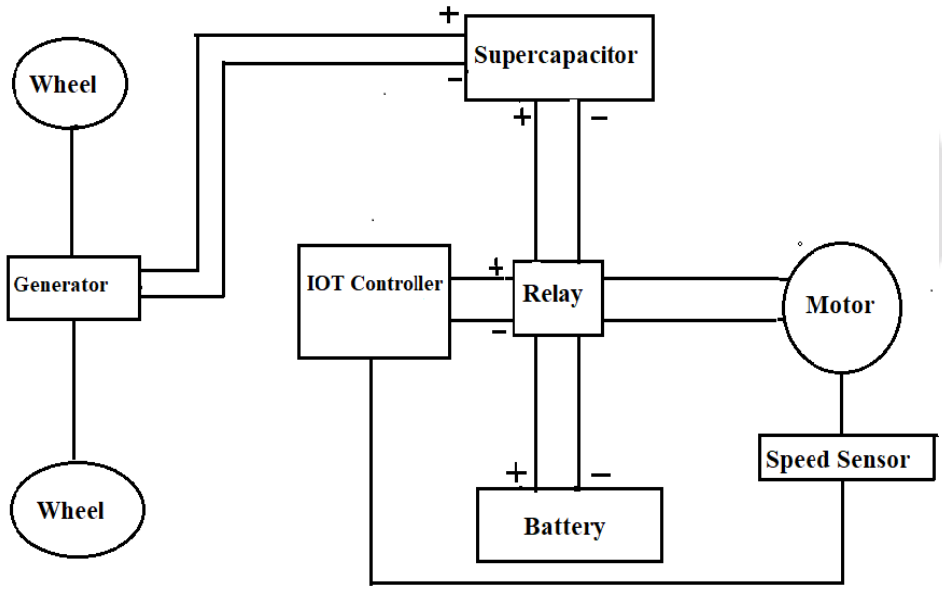


Fig -4: Generalised block diagram of the proposed system

Initially supply from the generator is given to the SCAP then it charges supercapapacitor charges within sec. power through supercapacitor is given to motor. Then motor starts and gives the mechanical energy to wheel. when the vehicle reach the steady state or weight of vehicle is zero, then supply through supercapacitor is cut by using relay. Then by using battery supply is given to run vehicle.

3.2 Working of The Prototype:

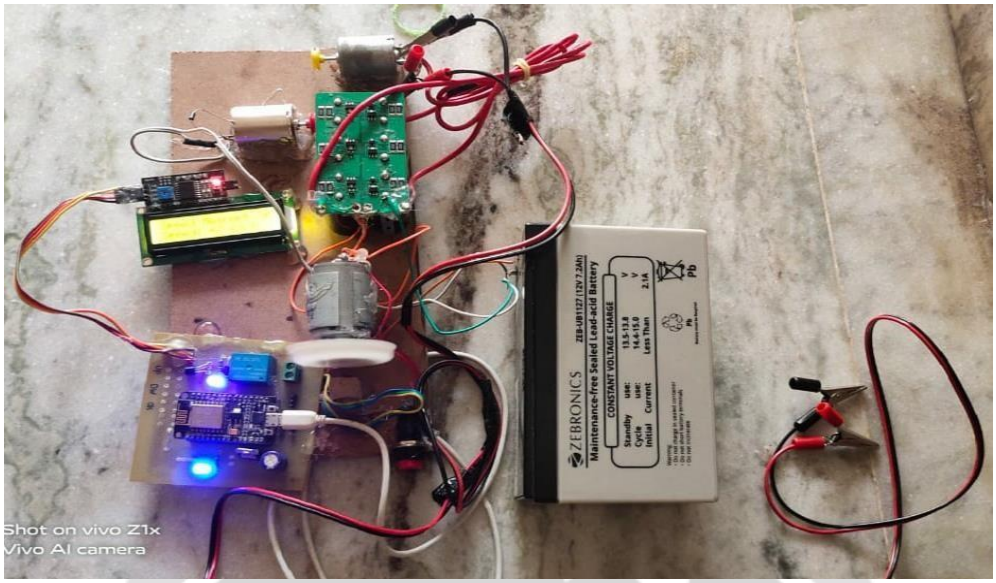


Fig- 5: Actual Hardware Model

Working of this prototype is divide in 2 stages:

Stage 1:

- Initially when Vehicle is at stand still position, the vehicle motor is powered with the charged stored in the Supercapacitor through relay 1.
- At steady position the total weight of vehicle is exerted on the road surface.
- As no movement of motors no charging of battery.
- The speed of vehicle is continuously measured by the sensor called "Hall Effect Sensor." and shown on the LCD Display.
- All the Controlling & Monitoring of sensors & other parameter is done by Controller ESP-8266.

Stage 2:

- As soon as the vehicle starts moving it gains speed above 25kmph, Supercapacitor gets discharging simultaneously.
- In moving condition, the vehicle loses its weight in the gravity, At the speed of 60kmph surface experience zero weight of that Vehicle and the consumption of power reduces.
- As the vehicle speed reaches 25kmph of speed the power supply switches on the battery and the generator attached to the wheels of Vehicle starts generating power and charge the Supercapacitor for further use.
- The NO switch is the connection between the power generation & Supercapacitor. On switch pressed, the Supercapacitor starts charging continuously.

4. ADVANTAGES

- Charges in seconds.
- Service life of vehicle is high.
- High power density.
- High efficiency.

- Wide operating temperature range and Environment friendly.
- Much longer shelf and cycle life than batteries.

5. DISADVANTAGES

- Super capacitors have much lower energy density than lithium batteries.
- The energy storage (kwh) requirement using supercapacitor is much smaller than using batteries.
- Higher self-discharge.

6. APPLICATIONS

- Hybrid - electric transient buses in the us and china.
- Electric braking system in passenger cars.
- Recently in stop go hybrid vehicles.
- Telecommunications
- Power quality
- Reliability requirements for uninterruptable power supply (UPS) installations.
- Computer system

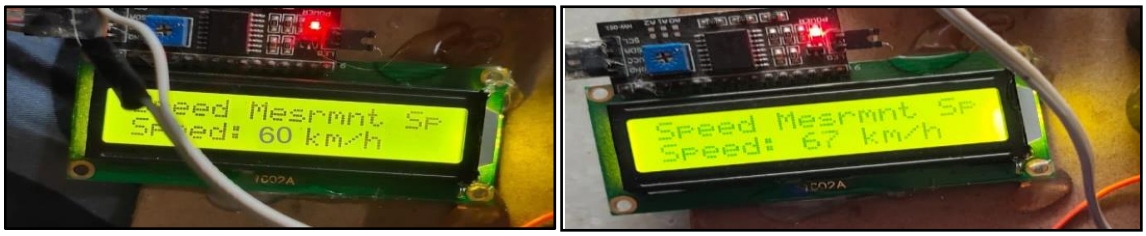
7. RESULT ANALYSIS

1. Speed of vehicle at stand still position:

2. In next result vehicle reach 23 km/hr

3. Speed of vehicle at running position:

In the third result supply to the motor is from battery, as the vehicle is at steady state. showing the speed of vehicle on LCD is 60 km/hr and 67 km/hr.



State	Speed	Power through
1	0-25 kmph	Supercapacitor
2	Above 25 kmph	Battery

Table- 2: Result Analysis

The result shows the working of Supercapacitor at speed 0-25km/hr. works for reducing the initial load of the vehicle from the battery after reaching speed above 25km/hr. it shifts on battery which increases the life cycle of the battery and motor the Supercapacitor provides high current as initially required and the charging time required very less as the combination of Supercapacitor and battery gives best performance in future vehicle

3.Speed of vehicle shown on Android App using IOT:

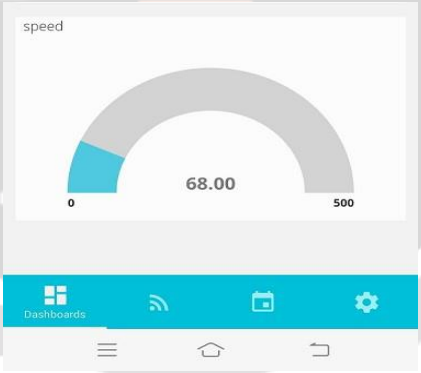


Fig- 6: Speed of vehicle shown on Android App using IOT:

8. FUTURE SCOPE:

This analysis may be extended within the close to future, combining various energy sources and powertrains in best approach, moreover as activity associate degree correct and sturdy power internal control formula, are essential to create a reliable and cheap electron volt whereas protective the environment and showing intelligence victimisation our restricted resources.

- One approach to cut back the gas emission within the transport sector is to alter transportation modes to
- become a lot of electrical.
- The planned system may be designed for any electrical vehicles.

- Price of auto can scale back thanks to increase in production rate of electrical vehicle.
- Supercapacitor is that the new supply of power for electrical cars is useful for future.

9. CONCLUSIONS

Thus during this paper main concentration on the operation of supercapacitors throughout ride through condition. With the assistance of supercapacitors the lifetime of battery is increase. By victimisation this mix, the general characteristic of battery is improved and therefore the performance of battery is improved. The SCAP model conferred during this paradigm could be a simplified model supported polynomial capacitance, that describes the SCAP cell energy behavior throughout the charge and discharge states. In different words, this model doesn't describe the SCAP behavior before and once the modules charge and discharge the utilization of Supercapacitor and battery along moreover as individual improve the system performance.

10. REFERENCES

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