CHAPTER 7

CONCLUSION & FUTURE SCOPE

7.1 CONCLUSION:

After reading many research papers and observing the work done in this area, it is found that many have lacked the reading and comparisons for the design of the hybrid storage system. The attempt made here is to design the hybrid storage system for electric vehicle such that it is beneficial to all kinds of vehicles – two, three and four wheelers. The initial experiments were done with small motor of DC of 2V supply and working with the supercapacitor of the capacity 1 F and 2.4 V. The results were so encouraging that the manual braking on the motor has stored the energy of the capacity 35% and it is reused when the motor is restarted. Later on, the same is tried with 12 V, motor - DC as well as PMSM, the regeneration has made many complications regarding the reverse current as well as the voltage level available with respect to regenerative time. The results for 9 V to 12 V are unsatisfactory and found to be challenging for the higher rating. The reverse current control and recognizing the same by the controller has been a decisive issue for the storage purpose. Manual characteristics for the selection of braking and notching has made the observations fruitful for the reading above 9V and the same storage system has been designed for the requirement of the vehicle.

The vehicular study has been raised looking for the demand to supply and store in case of two wheelers. The initially a bicycle of 200 W motor, BLDC has been tried for the 24 V supply voltage. The driver weight and the calculations for the supercapacitor have made it successful but economically not satisfactory. It is observed that if the need of power driving is more than the power storage capacity raises with the large capacity of supercapacitors. It is observed that 30-35% of rated power is stored in the amount of energy. Here, more complications rose with number of frequency of braking and the prediction of the braking. The prediction of braking is not possible without the proper data collection and its history recorded and data analysis. Through various techniques, Dampster Shafer Theory is found to be the best for diverse predictions as it works on the probability and certainty based on the historical diagnosis of data. Hence, the data recording for the two, three and four wheeler had been done with three diverse cycles – Urban, Semi-urban and rural. The BRTS route of Ahmedabad had been observed continuously for a month and found to be the best for the prediction. The driving cycle of BRTS is found exactly predictable for all the routes and better for the Hybrid Storage System.

Charge management in the battery is performed very effectively by the supercapacitor configuration. In the reference of battery life enhancement, the supercapacitor is most effective device. Using supercapacitors with battery, the storage capacity of battery can be improved which is reliable in the emergence. It is worth having the Dempster – Shafer Theory (DST) for implementing to decide the motoring mode and regeneration mode as the decision has to be taken in microseconds for the working of the quadrant of the motor. The variable parameters are based on the historical data of the type of cycle, drivers' decision and the method of driving. The switching signals are generated based on the load current direction, voltage of battery and voltage of SC available. The switching signals of the bidirectional DC – DC Converter (Buck Boost) are accordingly given to the driver of EV to charge the SC and Battery. An algorithm is developed to meet the criterion of Motoring and Generation using this Evidence Theory. The evidence theory (DST) is applied to find out the mode of operation for the Electric Vehicle. The data analysis has been done for the motoring mode and generation mode in three diverse cycles of operation as per Society of Automotive Engineers. The utilization of Electric vehicle with HSS has been proved here analytically that Heavy Electric Vehicles are well suitable for the urban cycle out of three available cycles – urban, semi-urban & sub-urban. The historical data of all two wheelers, three wheelers, four wheelers and heavy vehicle is analyzed for reliability and cost effectiveness. The data has been obtained by practical measurement of – notching period, running period, coasting period and the braking period. The results are well represented in the form of graph and all the four types of vehicles are compared for the cost effectiveness. The concluded efficient vehicle for the highly reliable storage system has been designed structure wise for the location of the battery bank and SC bank. The Center of Gravity has been calculated using AUTOCAD software. The diagrams of diverse possible designs are given (Fig. 6.12 – 6.14). The possible charging methods - wireless and wired are also predicted here.

TWO WHEELER:

The two wheelers tested are hero make and yo-bike make both are having capacity of 850 W BLDC. The no. of capacitors used are 17 of 4 Farad each having 5.5 Volt Capacity. It has generated average energy of 398.85 W.sec after continuous reading of 20 braking. Here, the speed is varied from 0 to 25 km per hour to 25 to 40 km per hour. The cycle followed is only urban cycle. The route is an urban route in diverse time periods – 6 to 8 am, 10 am to 1 pm and 4 to 6 pm in Ahmedabad, Gujarat. At that time the Battery Voltage is 46.8 Volt. The Energy generated is almost 1/3 of each cycle of driving.

THREE WHEELER:

The three wheelers tested are BEUT make and DEVAM make both are having capacity of 1150 W BLDC. The no. of capacitors used are 17 of 4 Farad each having 5.5 Volt Capacity. It has generated average energy of 1646.45 W.sec after continuous reading of 10 braking. Here, the speed is varied from 0 to 20 km per hour, 20 to 40 km per hour and 40 to 50 km per hour. The cycle followed is urban cycle as well as sub-urban cycle. The route is an urban route in diverse time periods – 10 am to 1 pm and 4 to 6 pm in Ahmedabad, Gujarat, for the sub-urban cycle same period but in Kalol, Dist. Gandhinagar and some Industrial Area of the Bavla, Dist. Ahmedabad. At that time the Battery Voltage is 51.6 Volt. The Energy generated is almost 1/3 of each cycle of driving.

FOUR WHEELER:

The four wheeler tested is REVA make having capacity of 2000 W BLDC. The no. of capacitors used are 17 of 4 Farad each having 5.5 Volt Capacity. It has generated average energy of 1951.23 W.sec after continuous reading of 30 braking. Here, the speed is varied from 0 to 20 km per hour, 20 to 40 km per hour and 40 to 60 km per hour. The cycle followed is urban cycle as well as sub-urban cycle. The routes tested are an urban as well as sub-urban route in diverse time periods – 10 am to 1 pm and 4 to 6 pm in Vadodara, Gujarat. At that time the Battery Voltage is 46.8 Volt. The Energy generated is almost 1/3 of each cycle of driving.

7.2 FUTURE SCOPE:

- The Wireless charging for the Vehicle can be implemented using diverse methods to remove the complications for the charging.
- The Location of the SC-Bank can be tested for the Heavy Vehicle and its Regeneration as well as Motoring.
- Other methods can be developed for the selection of the Driving Cycle of the Vehicle.
- The Fixed Route of the Vehicle can be predicted for the highest regeneration and implementation.
- The Fixed Route, with and without driver can be tested and the regeneration as well as utilization of the energy can be estimated.
- Other Topologies can be developed in the SC Bank Design, Optimized switching of SC can be done to increase the capacity by charging "Capacitance using Switching" and current capacity can be reduced.
- Battery Management System along with Temperature of SC Bank and Battery combination can be done for both motoring and generating mode.
- SC Bank with Battery can be tested for the Optimized current – minimum in case of Regeneration mode and maximum in case of motoring mode.
- The observations can be made real time based using diverse methods for continuous storage of the data and can be analytic.
- The diverse controllers available for the observations with prompt, intelligent programs. DSP, DSC based controlling can be obtained for the Energy Calculations.
- Artificial Intelligent Methods – AC, GA, ANN and TLBO can be implemented for the early stage probability of the prediction for the – SAE cycles.
- SC bank can be utilized for other applications like Elevators, Video recording, Mobile Towers, Hospitals and Renewable Energy Storage etc.