Battery Management System for E-Vehicle using Kalman Filter

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Abstract. For safe and proper battery management system the main aspect is to do a optimization of SOC which is State-of-Charge estimation. This paper gives you the maximum achievement of BMS with the electric vehicle Lithium ion Battery. Kalman filter design is implemented in this in order to reduce the mechanical noise and further voltage and current ripples where the man aim of this research work using Kalman is that it must have some proper sequence like a proper electronics and electrical model to get rid of the noises and ripples, thus the models current state and its system design is verified where it can apply to all sorts of problems and can apply to all such current manufacturers. From this point of view, we implemented a design which matches the output source of Kalman filter design and takes the less time for giving the accurate output. Hence the simulation with the Kalman filter design and its respective needed electronics components are therefore simulated and programmed by the MATLAB Simulink.

1. Introduction
At the intro part the electric vehicle takes a main role it has many forms of input sources that will make the motor to run for an electric vehicle [1-3]. It can be get the electricity from non-vehicle sources that we discuss further and also it can have its own battery system inbuilt [4-8]. The non or off-vehicle sources contains the renewable form of energy resources which are wind power, solar power and sometimes fuels are used to convert the system into electric vehicle by producing electricity on running the rotor [9-11]. Electric vehicles are not only working or limited road and railways of transport it can also run in the ships, aircrafts and space craft of systems which gives less cost and major advantages.

Electric vehicle first proposed in the era of 19th and mid- 19th centuries where at that period electricity used for motor kind of applications mainly used for toys and in further development it used for propulsion in vehicles which makes the use of vehicles in the easiest ways and gives the less cost that is not even achieved by the fuel type of engines in that time which makes the world to advanced level [12]. We used to hear about the modern internal combustion engine which makes the vehicles to run in great propulsion almost ruled most of the centuries and at the time of electric vehicle idea came it currently rules the world [14-17].

BMS which is abbreviated as battery management system which is kind of system to calculate all the aspects of battery whether it is running smoothly or it makes the system to its worse mainly it depends upon the atmosphere factors like the temperature in the outer environment which makes the system overheated and failure of batteries [18]. Thus, we are calculating the nominal voltage and currents carried out by the battery monitoring its state how it being in the atmosphere analysing the data about SOC which is state of charge calculating, it reporting it and balancing it [19].
In considering a thermal management system we can have the Liquid cooling system to lower the temperature of battery in the fossil fuel internal combustion engine we use the coolant oil for compensating the temperature where in this advanced technology we can use running cooling fan of applications. But liquid cooling has the major changes like it is the best system than the coolant fan type of applications. Batteries can directly implement with the coolant system without going for the battery management systems like it directly merged with the cooling system. If we use indirect cooling type of systems it makes the system heavy even it can compensate thermal quickly with its larger cooling channels [20].

The simulation is done using MATLAB Simulink it has the nice programming interfaces with the serial communication to the embedded systems in this research work we use both the MATLAB and Simulink which is a part of it. Its graphical programming interface is the main thing which gives the environment to interact with other type of domains such as control systems and VLSI. Simulink used in the way like simulating, analysing and interfacing with other systems which has vast number of libraries and can create a user defined library [21].

2. Existing system

In the existing system of technology, when there is a demand in Peak load all loads make the battery inn the situation of wear and tear which is carried out by the battery management system. Batteries historical performance cannot be seen due to lack of scalability from the manufacture side. In the existing system of methodology, the battery management systems are normal where it can only reduce the state of charge with respect to the normal battery performance. And it also makes the overall system design to complex. In the existing models of BMS system, the data acquisition is an important issue in our proposed model we can overcome all that kind of design and strategies [22-30].

3. Proposed system

In this proposed system we can see the improvised technology of battery management system which give great performance and overcome all the things of drawback which we saw in the previous models and papers. The performance of battery is all fine with the State of charge and its charge and discharging operations [13]. From the models of Thevenin’s the Kalman filter method is the one which cannot obtain its correct precision output because of its limited supplies of model precision. On creating a theory to solve that kind of problem we go for the second-order model of Thevenin’s algorithm. So from this we have the UKF which is abbreviated as Unscented Kalman Filter which leads to the idea of the Sage-Hausa adaptive algorithm and square root filter algorithm. Soc optimization and precision is more comfortable with the introduction of adaptive square root Unscented Kalman Filter (ASRUKF) algorithm. On experimenting the state of charge and its circuit the ASRUKF’s results shows the best way to get the high precision model of SOC experiments.
The above design (Fig. 1) describes the entire circuit diagram of this research work “Electric Vehicle Battery Management System Using Kalman Filter Design”.

Fig. 2 represents the current efficiency by three major things which are temperature condition, state of charge and coulombic efficiency.

The Fig. 3 represents the circuit of capacity correction where it gets the inputs from the outer battery temperature.

This above Fig. 4 represents the total circuit of Kalman filter configuration where its main module is to get the state of charge for the correct level of batteries charging and discharging operations.
The parameter configuration which is given as the input for Kalman filter design where it plays the main key role in designing shown in Fig. 5 and getting correct level of SOC with the MATLAB programming.

This above circuit (Fig. 6) represents the simulation stop method when there is a low State of charge in the circuit of BMS.

4. Output and Results
In this section provides the output and results of the Electric Vehicle Battery Management System Using Kalman Filter Design, it includes Current efficiency, Capacity correction, Error covariance and State of charge.

The Fig. 7 represents the output current efficiency from the battery.
The temperature compensation and capacity correction is shown in Fig. 8.

The error covariance from the Kalman filter represents in Fig. 9.

The state of charge is shown in Fig. 10.
The Fig. 10 and 11 represents the state of charges 1 and 2 with respect to x parameter of battery management system model.

**Conclusion**

By using this work of kalman filter based battery management system we have a high gain of state of charge and therefore there is a smooth maintenance needed for the batteries so that battery is enabled to enhance the electric vehicle power. And there is a great energy source. Thus the electric vehicle based battery management system using kalman filter is implemented using MATLAB Simulink.

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