As per UGC guidelines an electronic bar code is provided to seure your paper

International Journal for Modern Trends in Science and Technology, 8(07): 214-218, 2022

ISSN: 2455-3778 online
DOI: https://doi.org/10.46501/IJMTST0807031
Available online at: http://www.ijmtst.com/vol8issue07.html

Intelligent Battery Management System using Fuzzy Controller to Enhance the Performance of the Electric Vehicle

Madhuja R. Raut | Priyanka R. Khade

Department of Electrical Engineering, Walchand College of Engineering, Sangli, India.
Email: rautmadhuja@gmail.com

To Cite this Article
Madhuja R. Raut and Priyanka R. Khade. Intelligent Battery Management System using Fuzzy Controller to Enhance the Performance of the Electric Vehicle. International Journal for Modern Trends in Science and Technology 2022, 8(07), pp. 214-218. https://doi.org/10.46501/IJMTST0807031

Article Info
Received: 10 June 2022; Accepted: 07 July 2022; Published: 14 July 2022.

ABSTRACT

This thesis presents an overview of issues and technologies related to the proper design of charging infrastructures for the road electric vehicles. The analysis is carried out taking into account that the recharging stations of electric vehicles might be integrated in smart grids, which interconnect the main grid with distributed power plants, stationery electric storage systems and electric loads. In this paper, PID controller, fuzzy logic controller and a buck-boost converter is presented. DC and AC configurations of charging stations are compared in terms of the issues related to their impact on the main grid and the design of their main components. Specific attention was devoted also to the ultra-fast DC architecture, which appears a possible solution to positively affect a wide spread of plug-in hybrid and full electric road vehicles. This paper provides the information about fast charging of an electric vehicle developed in MATLAB

KEYWORDS: Battery charging, EVs, Buck-boost converter, Fuzzy logic controller, PID controller

1. INTRODUCTION

The main reason behind the electric vehicle invention is the emission of toxic substances into the air by the motor vehicles such as cars, buses, etc. The electric vehicles must be developed in such a way that the vehicle must be charged within a few seconds. Compared with conventional internal combustion engine based vehicles, EVs are powered by batteries that may charged from renewable power generated from the wind, solar or other forms of renewable sources. Among all battery types, Li-ion batteries are preferable power supplies for EVs due to a number of favorable characteristics such as power density, less pollution, and long service life. For Li-ion batteries, a proper battery charging strategy is essential in ensuring efficient and safe operations. The chargingstrategy is a key issue in the Battery Management System (BMS) of EVs. An optimal charging operation will protect batteries from damage, prolong the service life as well as improve the performance. The battery charging time, energyloss, and temperature rises are important factors to be considered in designing the battery charging process. The PID controller is used in a fast charging electric vehicle is always a closed-loop network and receives feedback.

This feedback is employed to make adjustments to the deviations in the output.Buck-boost converter along with the PID controller, FLC and Fuzzy-PID are presented as the advancedcontrolling circuit. The Fuzzy logic can be carried outeasily when related with the PID controller and isadoptable to the variations in the system. In this paper,MATLAB/Simulink is used for the representation of the connections in the network to complete the charging of the electric vehicle quickly.

This paper represents design of battery management system which is done by using buck-boost converter. Figure 1. Shows the proposed block diagram of battery management system using Buck-Boost and type of controllers. In which input DC supply is given to the Buck-Boost converter. As input voltage less than output voltage then system work as a boost converter to charge the battery. So, here this system works for both Buck as well as Boost conversion, depending on selection. Gate pulse from PWM generator to this Buck-Boost converter is generated by the controllers i.e. PID, Fuzzy and Fuzzy-PID and this gate pulse which is given to the Buck-Boost converter.

The input voltage and an input current of the battery has set to the particular value and from battery the parameters are taken out and which are given to the PWM generation. The circuit operates like this way. All this circuitry is developed in the MATLAB/Simulink software.

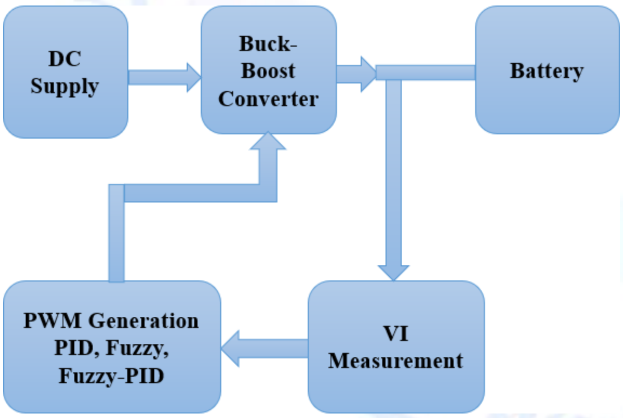


Figure 1: Block Diagram of Proposed Battery management system

2. Methodology

Battery Management System

The battery management system implements several safety features. These include undervoltage, overvoltage, short circuit, and open circuit detection. The battery pack is additionally protected by a battery protection board (or Battery Management System). The BMS measures the voltages of the individual battery cells as well as the charge/discharge current flowing through the battery. The BMS disconnect the battery as soon as the voltage or current values become outside of the specified limits. Trickle charging phenomenon is used which enables the battery to remain at its fully charged level.

Buck-Boost Converter

Buck- Boost converter includes the output voltage which may be exceeding or below the input voltage along with is a DC-DC converter. When the Buck converter remains combined with the boost converter, output voltage is usually similar to the input, and it can also be below or exceeding than the input. Configuration of Buck-Boost converter is shown as in figure 2. parameters are given in Table 2. Buck-Boost converter was chosen for this project due to its simpler concept than the rest.

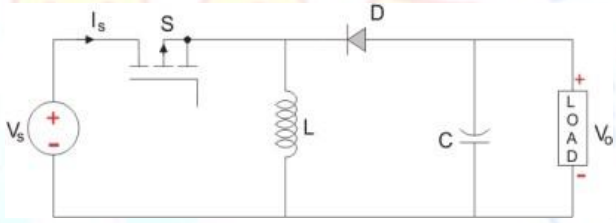


Figure 2: Configuration for buck-boost converter

Table 2: Parameters of Boost Converter

Parameters	**Values**
Input capacitor Cin	100 µF
Inductor L	0.0010 H
Input capacitor Cout	1000 µF

CCCV Techniques

In this paper, a triple objective function is first formulated for battery charging based on a selectable rate. An advanced optimal charging strategy is then proposed to develop the optimal Constant-Current-Constant-Voltage (CC-CV) charge current profile, which gives the best trade-off among three important objectives for battery management. Li-Ion batteries must be charged using the Constant Current Constant Voltage (CC-CV) charging method. This method consists of charging the battery at a constant current until a certain voltage threshold is reached, then gradually reducing the charging such that the constant cell voltage not exceeded. Charging is terminated once the current reaches a certain minimum threshold. This is a effective way to charge lithium batteries. When a lithium battery is nearly empty, we take constant current to charge it. We need to make sure that charging current should be lower than the max charging current that battery can accepted. With constant charging the voltage of battery is slowly increasing, when battery volt reaches the max charging voltage, charger would make sure charging voltage fixed as "constant voltage" and reduce the charging current. When battery is fully charged this state would be stopped. It is a hybrid approachthat combines the two charging methods. It uses CC charging in the first charging stage, and when the voltage reaches the maximum safe threshold value, the charging process shifts tothe CC charging method.

PID CONTROLLER

PID controller has implemented in this system for the comparison purpose. It gives measured response to the unmeasured disturbances. It reduces the time constant of the system. PID controller is adjusting the gain to increase or decrease or to operate the system in Buck or Boost mode. Battery parameters are obtained such as SOC,Voltage, and Current. It is very feasible and easy to implement.

FUZZY CONTROLLER

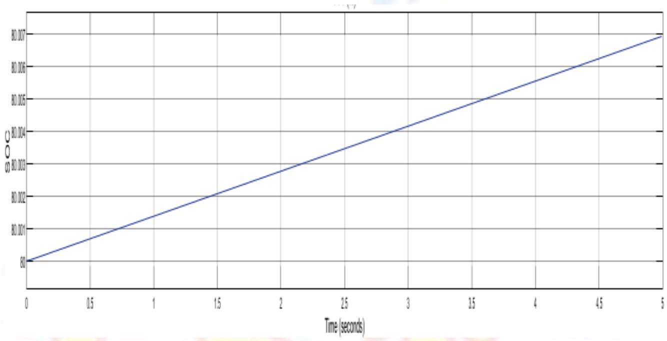
Model of Fuzzy controller has implemented for this system. In designing a Fuzzy logic controller, the process of forming Fuzzy rules plays a vital role. Fuzzy logic controller maintains the constant current while charging. With the technique of soft charging of battery, it helps to prevent the proper gravity and increase the battery life. Battery parameters are analyzed by such as SOC, Voltageand Current in the Simulink.

3. RESULTS

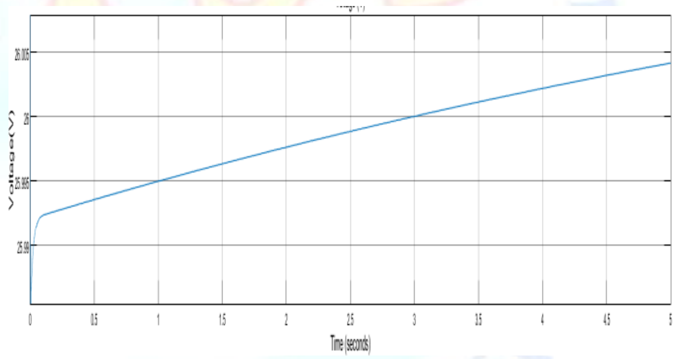
The simulation work is completed by the usage of MATLAB/Simulink and results are given in Figure 3.1.1, 3.2.1, 3.3.1 for PID controller, fuzzy logic, and fuzzy-PID controller respectively. The essential components of the simulation are Battery management system, Buck-boost converter, PID controller, Fuzzy controller, Fuzzy-PID controller, battery. In this simulation, three parameters of battery management are examined, i.e. For PID, Fuzzy, andFuzzy-PID controller.

PID CONTROLLER FOR BATTERY MANAGEMENT SYSTEM

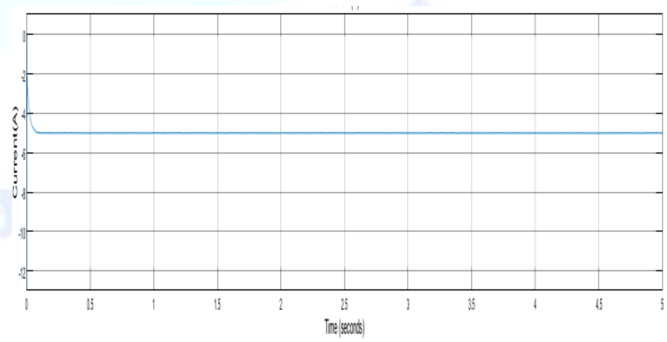
As shown in the figure 3.1.1, battery parameters are obtained from PID controller in the results of SOC, voltage, and current.In this, PID controller is adjusting the gain to increase or decrease or to operate the system in buck or boost mode. The SOC shown in figure 3.1.1 (1). The output voltage in figure (2) is increasing up to 26V that has been set. The output current is shown in figure 3.1.1 (3) is also goes to the set value i.e. 5A.



(1)



(2)

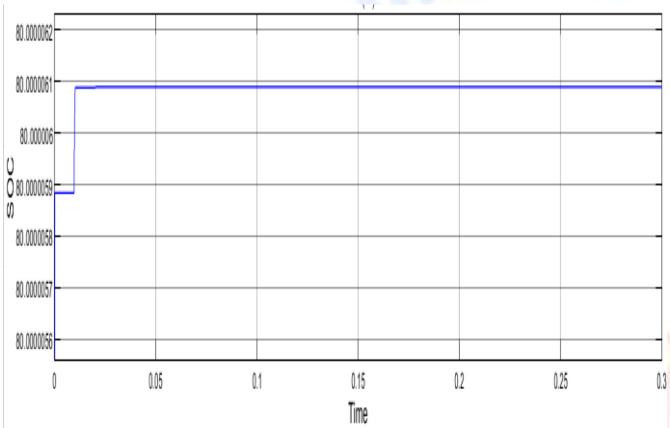


(3)

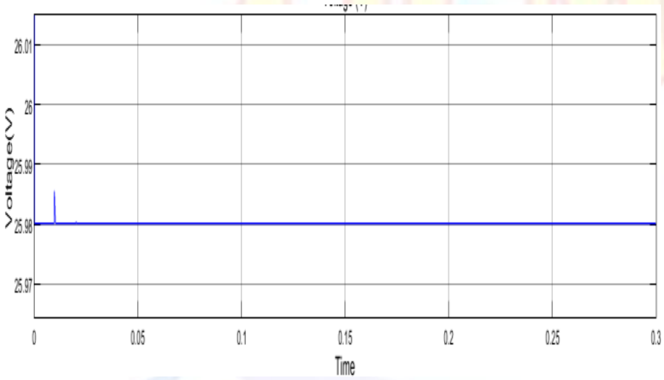
Figure 3.1.1 :Simulation results of battery management system for PIDcontroller: (1) SOC (2) Output Voltage (3) Output Current

FUZZY CONTROLLER FOR BATTERY MANAGEMENT SYSTEM

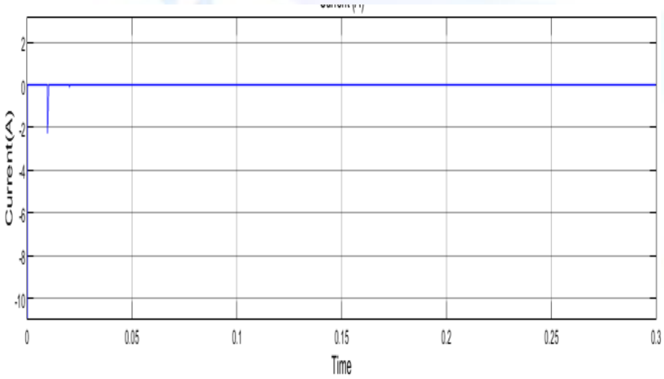
As shown in the figure 3.2.1, battery parameters are obtained from Fuzzy controller in the simulation results of SOC, voltage and current. The SOC in figure 3.2.1 (1) which is increasing in steps. The output voltage is reaching at desired value as shown in figure 3.2.1 (2) is reaching to the set value i.e. 26V. The output current also reaching to the desired value as shown in figure 3.2.1 (3). In EV, FLC maintains constant current for charging. This result shows the suitability of the FLC for fast DC charging of EV.



(1)



(2)



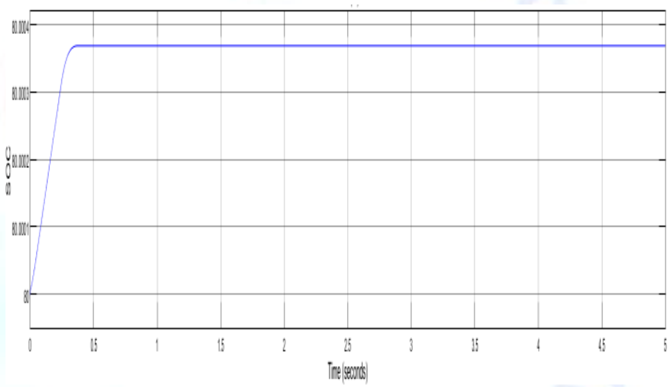
(3)

Figure 3.2.1 : Simulation results of battery management system forFuzzy controller : (1) SOC (2) Output Voltage (3) Output Current

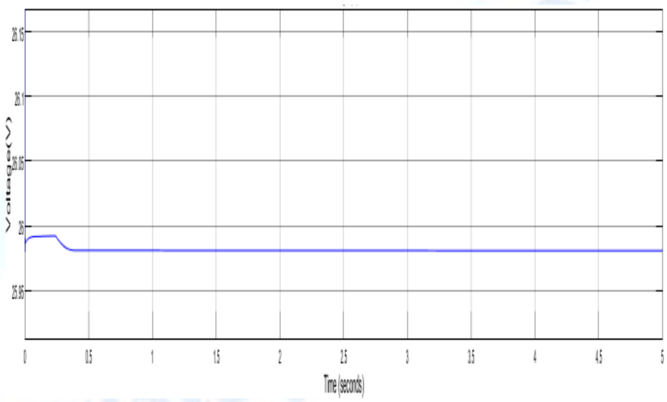
FUZZY-PID CONTROLLER FOR BATTERY MANAGEMENT SYSTEM

Battery parameters are obtained obtained from Fuzzy-PID controller. It is called DC fast charging. Lithium-ion battery is used to test the charging. Figure 3.3.1 shows the results of simulation. Trickle charging phenomenon is used which longers the battery life. Due to this phenomenon, gravity of the battery is maintained at proper charge and also battery everlasting property gets increased The smooth SOC curve

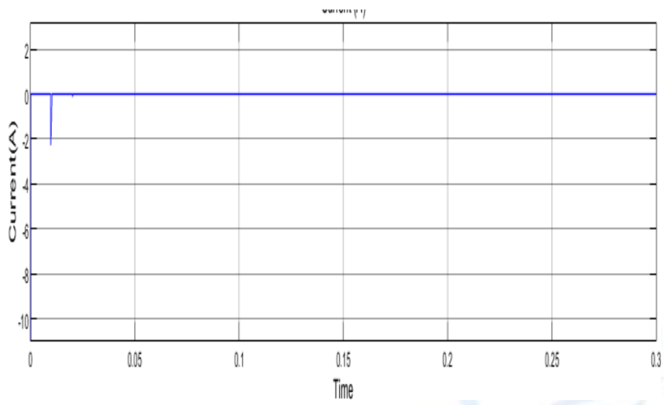
obtained which is shown in figure 3.3.1 (1). And the output voltage shown in figure (2) and output current which is obtained shown in figure (3). By giving input 12V to the battery, it charges up to the 26 v i.e. Battery voltage boosts at a particular level that has been set. All the results are displayed which are taken from the Simulink.



(1)



(2)



(3)

Figure 3.3.1 : Simulation results of battery management system for Fuzzy- PID controller : (1) SOC (2) Output Voltage (3) Output Current

4. CONCLUSION

The proposed Fuzzy logic controller is designed effectively and successfully in this paper. All objectives are accomplished efficiently. All circuit elements are designed successfully. By using MATLAB, the total simulation design has been advanced. Byusing MATLAB, the total simulation design has been advanced. The proposed battery management system can produced 3 types of controller results : (1) Battery charging using PID controller (2) Battery charging using Fuzzy logic controller (3) Battery charging using Fuzzy-PID controller. The results carried out successfully with the help of Buck-Boost converter and other controlling strategies. From the results, CCCV technique is correctly applied to get output as in 3 different parameters.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

REFERENCES

[1] Byung-kwon Lee, Jong-Pil Kim, Sam-Gyun Kim, and Jun-Young Lee, "An Isolated/Bidirectional PWM Resonant Converter for V2G(H) EV On-Board Charger," IEEE Trans. Veh. Technol., vol. 66, no. 9, pp. 7741- 7750, Sept. 2017.

[2] Research and design of lithium battery management system for electrical bicycle based on Internet of things technology, IEEE conference NOV 2019

[3] S. J. Gerssen-Gondelach and A. P. C. Faaij, "Performance of batteries for electric vehicles on short and longer term," J. Power Sour., vol.212,pp. 111-129, Aug. 2012.

[4] Kang Miao Tan, Vigna K. Ramachandramurthy and Jia Ying Yong, "Bidrectional Battery Charger for Electric Vehicle," in Proc. IEEE Innovative Smart Grid Technologies-Aisa, May 2014, pp. 406-411.

[5] V. Khadkikar, A. Chandra, A. O. Barry, and T. D. Naguyen, "Application of UPQC to protect a sensitive load on a polluted distribution network," in Proc. Annu. Conf. IEEE Power Eng. Soc. Gen. Meeting, 2006, pp. 867- 872.

[6] Nadia Mei Lin Tan, Takahiro Abe, and Hirofumi Akagi, "Design and Performance of a Bidirectional Isolated DC-DC Converter for a Battery Energy Storage System," IEEE Trans. Power Electron., vol.27, no. 3, pp. 1237-1248, Mar. 2012.

[7] Dylan C. Erb, Omer C. Onar and Alireza Khaligh, "Bi-Directional Charging Topologies for Plug-in Hybrid Electric Vehicles," in Proc. IEEE Appl. Power Electron. Conf., Feb. 2010, pp. 2066-2072.

[8] M. Zaheer, N. Patel and A. P. Hu, "Parallel tuned contactless power pickup using saturable core reactor," in Proc. Int. Conf. Sustain. Energy Technol.,Dec.2010, pp.1-6