An Investigation of Energy Storage System using ANN

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Abstract- In this paper, we study and implement techniques for design of Hybrid Energy Storage System for Electric Vehicles which is the key to the proper functioning of electric vehicles. Regularly expanding electricity utilization offers ascend to guidelines and noteworthy undertakings to improve the energy proficiency in a wide range of movement from assembling to trade, from transportation to advanced correspondence, from amusement to PCs and compact gadgets. A significant innovation for decreasing energy utilization is the capacity to store any overabundance electrical energy for extensive stretches of time and productively recover the put away energy. This is studied and implemented in MATLAB Simulink on the perspective of electric vehicles specifically for hybrid energy storage system. The proposed hybrid electric storage system consists of lithium ion battery and super capacitor to charge the electric vehicle. The control system is designed using Artificial Neural Network to enhance the results obtained using the PI controlled techniques. It reduces the calculation complexity of the system by reducing the values of Kp and Ki calculations. The neural network promotes self-learning capability of the system and also improves the system by reducing any fluctuations if any.

Keywords- energy storage system, energy proficiency, Electric Vehicles, Hybrid Energy Storage System, Artificial Neural Network

I. INTRODUCTION

Because of the contamination brought about by petroleum product, new energy sources have been ceaselessly created. These days, installed energy storage systems in current age electric vehicles are for the most part dependent on the Li-ions batteries which, with high energy thickness, can give long separation continuance to electric vehicles. While contrasted with the super capacitor, the reaction of Li-ions batteries is slower than that of super capacitors.[1] Along these lines, so as to make electric vehicles equivalent to fuel vehicles with respect to quick transient acceleration, energy, and long-separate continuance, a hybrid energy storage system (HESS) comprising of Li-ions batteries and super-capacitors is connected to electric vehicles.[1][For the advancement of electric vehicles, improving the energy storage gadget is basic, and it is important to think about expanding the capacity of the battery, while diminishing the size and weight of the battery to build the charging rate. [4][5]

DC-DC converters which assume a significant job in hybrid energy storage system have been grown quickly throughout the years. Through a progression of advancements, an assortment of DC-DC converters. [6] Another zero Voltage Switch (ZVS) bidirectional DC-DC converter is in, which has great controllability to improve change effectiveness, yet isn't reasonable for electric vehicles because of the mind-boggling control and greater expense. It has been appeared separated bi-directional DC-DC converter with complex structure can change over a huge power transmission. Another zero-swell switching DC-to-DC converter with the coordinated attractive advancements. what's more, the application is effective. Segregated interleaved DC/DC converter presents the idea of three-winding coupled inductors, however it is progressively reasonable for power transmission.

It is significant for hybrid energy storage systems to choose an appropriate energy the executives technique. Energy the execution procedures have been broadly announced in writing in the ongoing years, including neural networks, fuzzy logic, state machine control, recurrence decoupling technique, on/disconnected ideal systems, dynamic programming (DP) and restriction of battery power. The fundamental goal of the ideal control systems is to guarantee a persistent supply by the minimization of a cost capacity. [2] These systems can be separated into disconnected worldwide improvement and on-line nearby streamlining. For disconnected worldwide enhancement, it is important to acquire the best power dispersion between various sources. In the meantime, for on-line nearby improvement, accurate predication driving conditions is important. [7][8].

In this work, another incorporated structure of DC-DC converter and connected on hybrid energy storage system for electric vehicles. The DC-DC converter gives the particular topology and working modes, just as Li-ions battery and super capacitor control. With respect to energy the executive's system, the paper proposes an enhancement control calculation planned utilizing a Li-ions battery power dynamic confinement rule-put together control based with respect to the condition of charge (SOC) of the super-capacitor. [9] So as to improve the life and decrease the extent of hybrid energy storage system, the paper utilizes a hybrid calculation dependent on molecule swarm streamlining and Nelder-Mead simplex approach to upgrade the control parameters. At long last, the reproduction and exploratory examination confirm the hybrid energy storage system execution. [10]

II. IMPLEMENTATION AND RESULT

Artificial neural networks are the demonstrating of the human mind with the most straightforward definition and building squares are neurons. There are around 100 billion neurons in the human cerebrum. Each neuron has an association point somewhere in the range of 1,000 and 100,000. In the human mind, data is stored so as to be circulated, and we can extract more than one bit of this data when essential from our memory in parallel. We are not mixed up when we state that a human mind is comprised of thousands of, powerful parallel processors. In multi-layer artificial neural networks, there are likewise neurons placed along these lines to the human mind. Each neuron is associated with different neurons with specific coefficients. Amid preparing, data is disseminated to these association focuses with the goal that the network is found out**.**

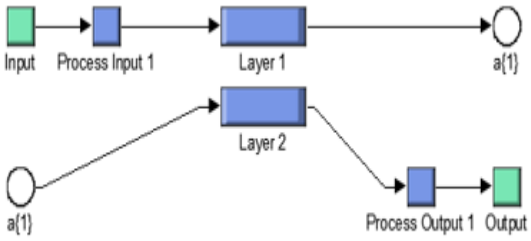


Fig.1: Artificial Neural Network layer network

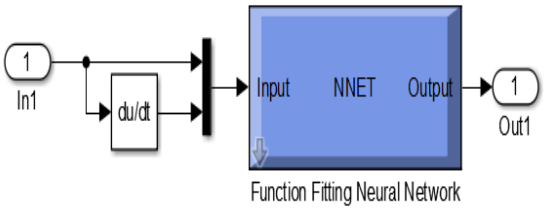


Fig.2: ANN Subsystem

The network design has an info layer, concealed layer (there can be mutiple) and the yield layer. It is likewise called MLP (Multi-Layer Perceptron) in light of the different layers. The shrouded layer can be viewed as a "refining layer" that distils a portion of the significant examples from the sources of info and passes it onto the following layer to see. It makes the network quicker and productive by recognizing just the significant data from the sources of info forgetting the repetitive data.

Advantages of Artificial Neural Networks:

• Storing data on the whole network: Information, for example, in customary writing computer programs is stored on the whole network, not on a database. The vanishing of a couple of snippets of data in a single place does not keep the network from working

• Ability to work with inadequate learning: After ANN preparing, the information may deliver yield even with deficient data. The loss of execution here relies upon the significance of the missing data.

• Having adaptation to internal failure: Corruption of at least one cells of ANN does not keep it from producing yield. This element makes the networks flaw tolerant.

• Having a circulated memory: In request for ANN to have the capacity to learn, it is important to decide the precedents and to teach the network according to the ideal yield by demonstrating these guides to the network. The network's prosperity is legitimately proportional to the chosen cases, and if the occasion can't be appeared to the network in the entirety of its perspectives, the network can create false yield.

• Gradual debasement: A network moderates after some time and experiences relative corruption. The network issue does not promptly erode right away

• Parallel preparing capacity: Artificial neural networks have numerical quality that can perform more than one employment in the meantime**.**

Block diagram:

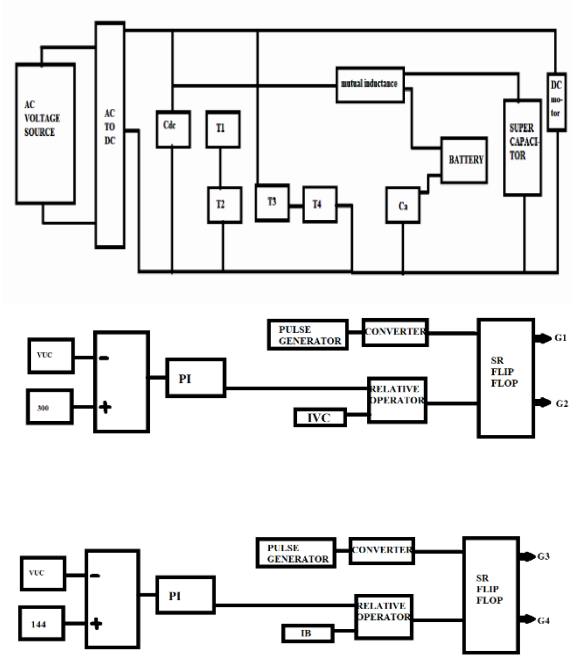


Fig.3: Hybrid energy storage system applied to electric vehicles in PI model

The above figure shows the Hybrid energy storage system applied to electric vehicles in PI model, it consisting of a bridge rectifier super capacitor battery and sub system, here we are adding the proportional integral controller.

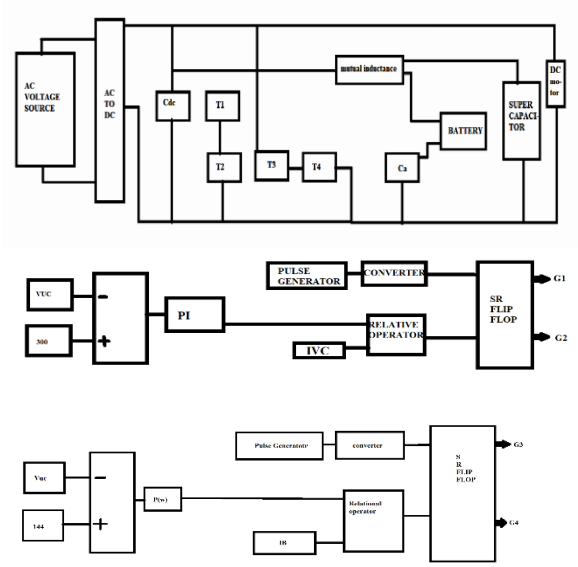
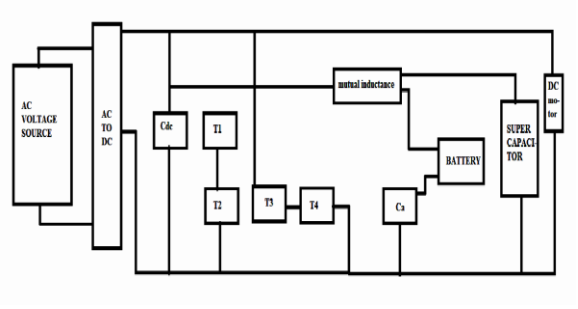


Fig.4: Hybrid energy storage system applied to electric vehicles in PI model and power command

The figure 4 shows the Hybrid energy storage system applied to electric vehicles in PI model and power command it consisting of bridge circuit super capacitor battery a sub system, here we are adding the power command also it will give the efficient output

The main advantage of artificial neural network compare to proportional integral is it can handle large amount data sets and it has the ability to the implicitly detect non-linear relationship between the dependent and independent values. Storing information on the entire network: Information such as in traditional programming is stored on the entire network, not on a database. The disappearance of a few pieces of information in one place does not prevent the network from functioning



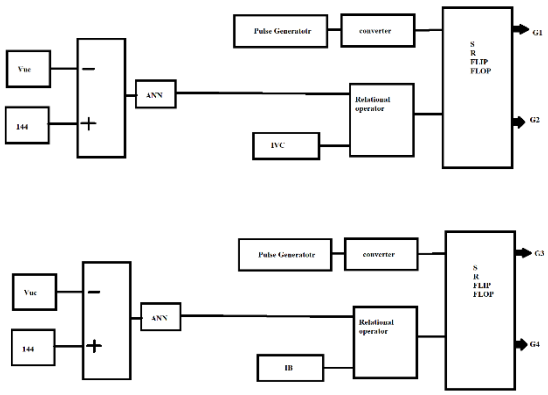


Fig.5: Proposed Hybrid energy storage system applied to electric vehicles in ANN

The above figure shows the Proposed Hybrid energy storage system applied to electric vehicles in ANN, here we are using the artificial neural network the ANN having many advantages compared to PI.

III. RESULT

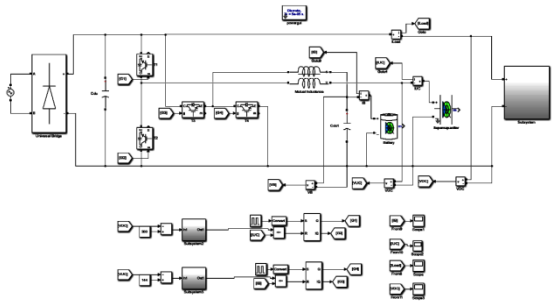


Fig.6: ANN based proposed model

The above figure 6 shows the MATLAB Simulink of ANN model. This shows the proposed hybrid energy storage system to electric vehicles in ANN.

Table 1: Comparison table of THD of PI controller and ANN

SL NO:	SIGNAL NAME	THD in PI technique	THD in ANN techniques
1	IB	109.85	80.59
2	IUC	76.48	66
3	Power Load PI	80.31	77.13
4	Power Battery	80.31	77.05
5	Power UC	80.31	77.13

The table 1 shows the Comparison table of THD of PI controller and ANN.here we can see the different parameter value in THD in PI techniques and THD in ANN techniques. And the parameters are battery current, ultra-capacitive current, power load in PI, power battery and power UC values are displayed in table. The low value we have get in v compare to THD in PI techniques.

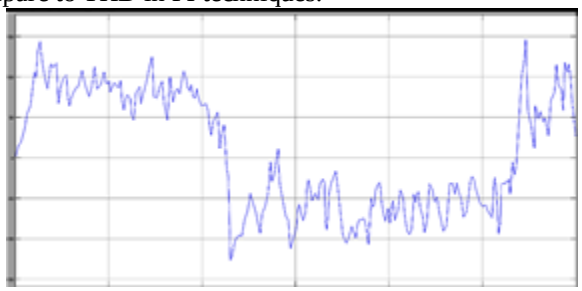


Fig.7: Power command and actual power of HESS applied on electric vehicles

The above figure shows the power command and actual power proposed hybrid energy storage system. Here the graph shows the power command and actual power of the system, the power variation is started to zero and the high value 150 w the 0 to 100 t/s it become high level.

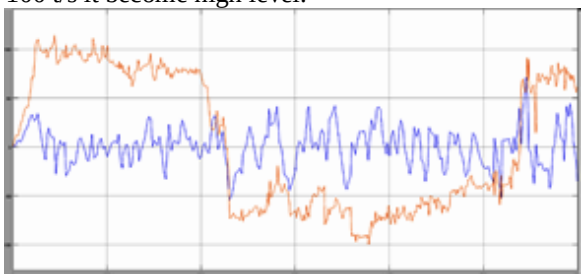


Fig.8: Power of the super-capacitor and Li-ion battery HESS applied on electric vehicles

The above figure is the waveform of Power of the super-capacitor and Li-ion battery HESS applied on electric vehicles here comparing the power of super capacitor and li-ion battery, the li-ion battery having high power variation in power compared to super capacitor.

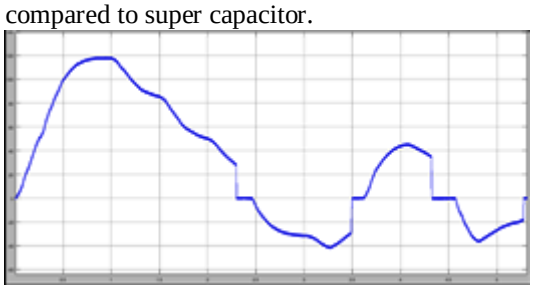


Fig.9: Battery current proposed system

The above figure shows the battery current of proposed system the battery current changes are smoother with no instantaneous perturbations. We can see in this graph the output current of the battery pack is smooth and has minimal ripple content

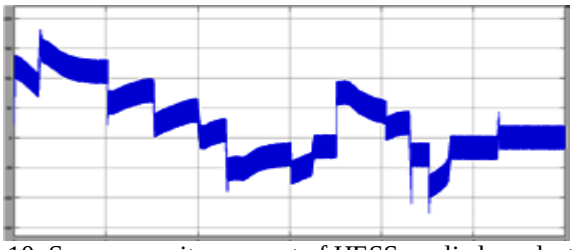


Fig.10: Super-capacitor current of HESS applied on electric vehicles

Figure shows the super capacitor current of proposed system. Compared to battery current the super capacitor current is having high ripple content.

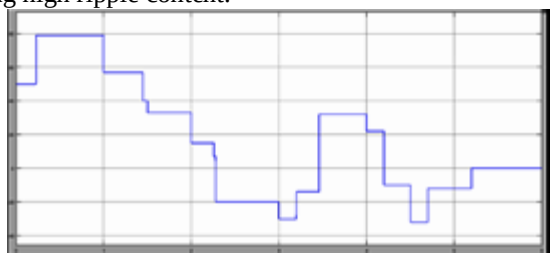


Fig.11: Load current of HESS applied on electric vehicles

The above figure shows the load current of HESS applied on electric vehicles in proposed system, here we can see the small amount of fluctuation in load current

Fig.12: Load voltage of HESS applied on electric vehicles

The figure shows the load voltage of proposed system, the load voltage having small amount fluctuation

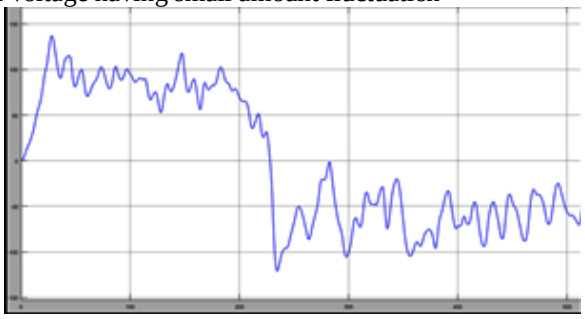


Fig.13: Power command and actual power of proposed system

The figure 12 shows the Power command and actual power of proposed system, figure shows variation of power command

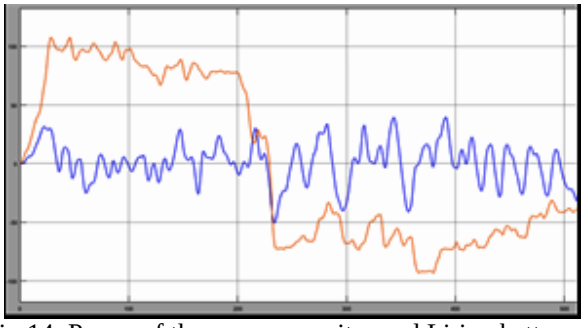


Fig.14: Power of the super-capacitor and Li-ion battery of proposed system

The figure 13 shows the Power of the super-capacitor and Li-ion battery proposed system here shows the Power of the super-capacitor and Li-ion battery.

IV. FUTURE SCOPE

It is additionally obvious that, so as to locate the most appropriate arrangement, the entire scope of HESS and control choices must be considered for a predefined cycle, in spite of the fact that control techniques are typically created for a particular HESS topology. This infers, when structuring a HESS and once the EB cycle is known, the HESS topology ought to be picked relying upon the control technique that the creator can give so the equipment multifaceted nature coordinates the product intricacy. HESS fashioners ought to play out an investigation like the one in this work so as to locate the most appropriate answer for their particular application, which ought to incorporate, in the last stage, an interpretation to practical terms for boosting benefits. Further work can be done on hybrid systems including a source of renewable energy like solar and wind system.

V. CONCLUSION

Hence, we are studied and implemented hybrid energy storage system in electrical vehicle using artificial neural network. Another hybrid energy storage system for electric vehicles is planned dependent on a Li-ions battery power dynamic restriction rule-based HESS energy the executives and another bi-directional DC/DC converter with Artificial Neural Network. The system is contrasted with conventional hybrid energy storage system, demonstrating it has critical preferred standpoint of diminished counts and gives consistent voltage to the electric vehicle. Besides, the swell of yield current is diminished and thusly the life of battery is improved.

VI. REFERENCES

[1]. Linda Barelli ID et al., "Dynamic Analysis of a Hybrid Energy Storage System (H-ESS) Coupled to a Photovoltaic (PV) Plant" 10 January 2018; Accepted: 2 February 2018; Published: 8 February 2018

[2]. Younghyun Kim, et al., "Computer-Aided Design and Optimization of Hybrid Energy Storage Systems" Electronic Design Automation Vol. 7, No. 4 (2013) 247–338 c 2013

[3]. Ian C. Smith et al., "Benefits of Battery-U Ultracapacitor Hybrid Energy Storage Systems" May 17, 2012,

[4]. Karl BA.et al., "Design and Evaluation of Hybrid Energy Storage Systems for Electric Powertrains" Waterloo, Ontario, Canada, 2010 © Karl BA. Mikkelsen 2010

[5]. S. Piriienkoet al., "Optimization of Hybrid Energy Storage System for Electric Vehicles" Manuscript received: September 15, 2016; accepted: November 24, 2016.

[6]. Tobias Anderssona, et al., "Alternative Energy Storage System for Hybrid Electric Vehicles" IEEE AES magazine, p14- 19, 1992

[7]. M. Gopikrishnan et al, "Battery/ultra-Capacitor Hybrid Energy Storage System for Electric, Hybrid and Plug-in Hybrid Electric Vehicles" Middle-East Journal of Scientific Research 20 (9): 1122-1126, 2014

[8]. Xiaodong Zhang, et al., "A Multi-hybrid Energy System for Hybrid Electric Vehicles" World Electric Vehicle Journal Vol. 4 - ISSN 2032-6653 - © 2010 WEVA

[9]. Jianjun Hu et al., "Energy Management Strategy for the Hybrid Energy Storage System of Pure Electric Vehicle Considering Traffic Information" 8 July 2018; Accepted: 28 July 2018; Published: 31 July 2018.

[10]. Huilong Yu et al., "Multi-objective Optimal Sizing and Energy Management of Hybrid Energy Storage System for Electric Vehicles" Cao, Member, IEEE, and Fei-Yue Wang, Fellow, IEEE, march 2009

[11]. Rached Dhaouadi et al., "Synergetic Control of a Hybrid Battery-Ultracapacitor Energy Storage System" IEEE Transactions on Industrial Electronics. 2010;57(12):3917-3926

[12]. A. Jaya Laxmi et al., "Comparison of PI and ANN Control Strategies of Unified Shunt Series Compensator" 2006 IEEE.

[13]. Aarthi et al.," Comparison of Pi, Fuzzy Logic and Neural Networks Based Control of Doubly Fed Induction Generator in Wind Energy Generation" Vol. 1 Issue 6, August 2014.

[14]. A. Jaya Laxmi et al., "Comparison of PI and ANN Control Strategies of Unified Shunt Series Compensator" 2006

[15]. Aamir et al., "On replacing PID controller with ANN controller for DC motor position control" April 2013

[16]. Wei Lu et al., "The PID Controller Based on the Artificial Neural Network and the Differential Evolution Algorithm" VOL. 7, NO. 10, OCTOBER 2012

[17]. N. Ramchandra et al., "Comparison of Different Controllers on Unified Power Quality Conditioner" Volume 2, Issue 9 (September 2012), PP 06-14.

[18]. Vikram Chopra et al., "Comparative Analysis of Tuning a PID Controller using Intelligent Methods" Vol. 11, No. 8, 2014.

[19]. Sayara Y et al., "Comparison Of Pi And Ann Controller For Hvdc Link" 2006-2015

[20]. V. Anantha Lakshmi et al., "Comparison of Dynamic Performance of ANN and PID Controllers for an Interconnected Hydro - Thermal System" Volume: 03, Special Issue No: 02, March 2017

[21]. Ishmeen Kaur Sra et al., "Position Control of DC Motor by using PID, FLC, ANN Controller Techniques and the Comparison of Performances"