Energy Storage System Using Battery and Super Capacitor for Electric Vehicles

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Abstract
A hybrid electric vehicle energy storage system is being researched. Because of the rising need for energy, additional oversight and control, as well as specialised processes, are required. Efforts to reduce energy use in the construction, transportation, and commercial sectors are examples of this. Increasing numbers of individuals are turning to laptops, cellphones, and portable PCs for their leisure. Renewable energy resources are not the same as the capacity to store energy for lengthy periods of time employing energy conservation technology. In order to fully understand this topic, a substantial amount of investigation is required. Electric cars' function in hybrid energy storage systems is an important part of understanding their respective points of view. To provide more accurate results, PI and neural networks are used in this thesis. PI and neural networks are used in a novel way to do this.

Keywords
Electric Vehicle, Neural Network, PI, Hybrid Energy

I. Introduction

For a long time, the only option for a healthy, long life on Earth was to burn oil. People all throughout the globe now have more options for how they want to live as a result of oil. As a result of their lower use of gasoline, HEVs are expected to become more and more popular as transportation options in the future. As a result, hybrid electric cars need energy storage devices (HEVs). The optimal ways to use energy storage technology have not yet been studied. It's important that the weight-to-energy ratio of the power storage technologies be reasonable [2–6].

A growing number of people are opting for hybrid, plug-in hybrid, and electric vehicles (EVs) as a means of reducing their carbon footprint. Many additional hydrogen-powered automobiles (HEVs) were created after the Toyota Prius was released in 1997 to suit government regulations and/or consumer requirements.

Ni-MH batteries power the vast majority of today's Hybrid Electric Vehicles (HEVs). Even yet, light HEVs, which have fewer amenities and must be produced on a budget, still employ lead-acid battery technology. Because of their low cost and extended lifespan, lead-acid batteries are an excellent option for automobiles [9]. Their cycle life, power, and weight, on the other hand, are all constrained. There is ongoing work being done to improve them [10–15], and new concepts have emerged that go beyond just increasing the size of the battery. Energy storage systems (ESS) that employ several energy storage devices to enhance their cycle life, power characteristics, and operating efficiency are called "Hybrid Energy Storage Systems" (HESS). Figure 1 depicts a hybrid energy storage system. Ultracapacitors and lead-acid batteries, two power storage technologies, are included in the system. [16-19] Hybrid Energy Storage Systems, which may be thought of as a storage device that is utilised differently depending on how the vehicle is charged and operated, might also make a huge impact (advanced HESS).

In this paper, a new HESS with a BMS-supplied storage device selection function is described in detail. In addition, tests are carried out to determine the extent to which moderate HEV usage has improved in terms of energy efficiency [20].

A more complicated energy storage system is needed since the basic mild HEV has a relatively large current and a limited operational voltage range. High current discharges rise with the idle stop and start function, for example, because there are more engine starts.

Performance and cycle life may be harmed by a beginning current rate of 10 to 15 kilohertz. The capacity of a vehicle to create energy when it brakes is one of the most critical factors affecting its performance. To put it another way, the battery receives a large quantity of charge in a short period of time. Batteries are under a lot of stress because of this [15].

However, even though batteries are often employed to store energy in automobiles, the chemical processes that take place when energy is put into or taken out restrict how long they can charge or discharge at high currents. How to create an electric car's hybrid energy storage system is explained in this research using the NNPI controller.

II. Implementation

When individuals are researched using techniques that are not specific to them, the functioning of their brains may be used to characterise their personalities. It is estimated that the human brain has something in the neighbourhood of 100 billion neurons. There is a distance of 1,100,000 ten-thousandths of an inch between the stages of connection for each neuron (0.1 mm or 0.01 m). According to this hypothesis, information that may be used as a reference is stored in people's brains, and this information can be retrieved by pulling out one piece at a time rather than accessing it in sequence. Moreover, this information can be accessible at any moment..

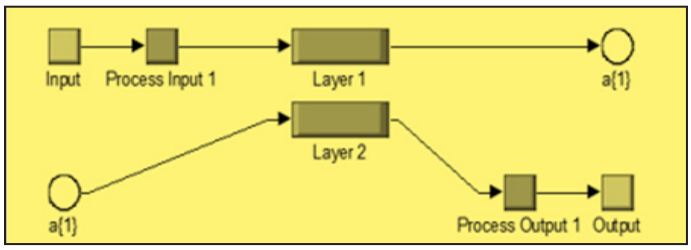

Fig. 1: NN Layers

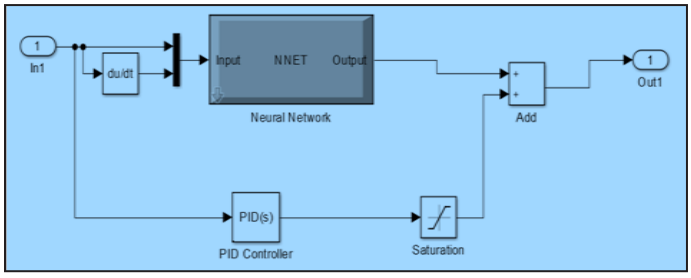

Fig. 2: Control System with NN and PI

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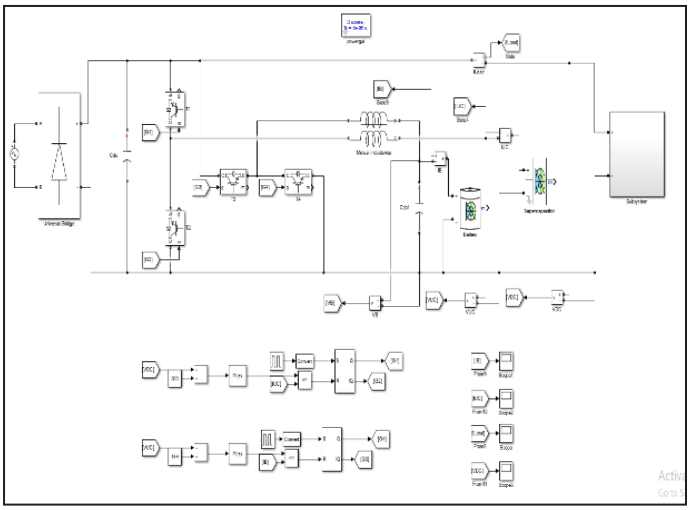

Fig. 3: HESS Energy Storage Applied to Electric Vehicles in PI Model

Electric vehicles, in accordance with the PI model, are said to be furnished with the HESS Energy Storage device. An integrated proportional controller is already included into a bridge rectifier super capacitor battery and subsystem..

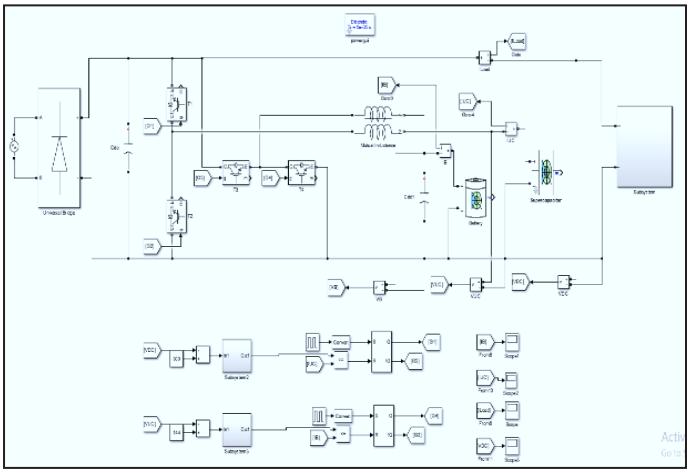

Fig. 4: Final Simulink Model NNPI

The HESS Energy Storage system for electric automobiles in NNPI is shown in Fig. 1. This system makes use of both PI and an Artificial Neural Network (ANN). In many respects, opting for NNPI rather than PI is the superior decision..

II. Results

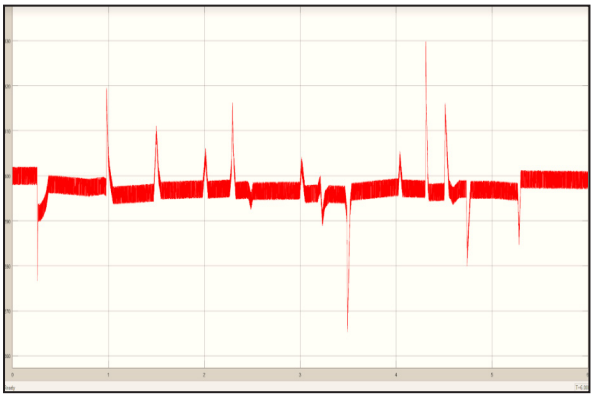

Fig. 5: Vdc for PI Controller

High fluctuating output for PI controller result is shown above.

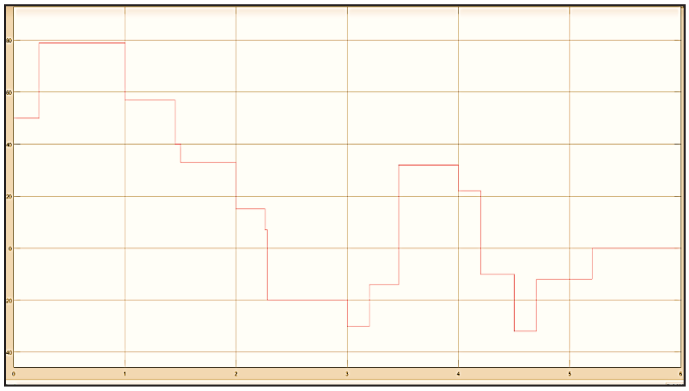

Fig. 6: Battery Load Current PI based

PI based load current is shown above.

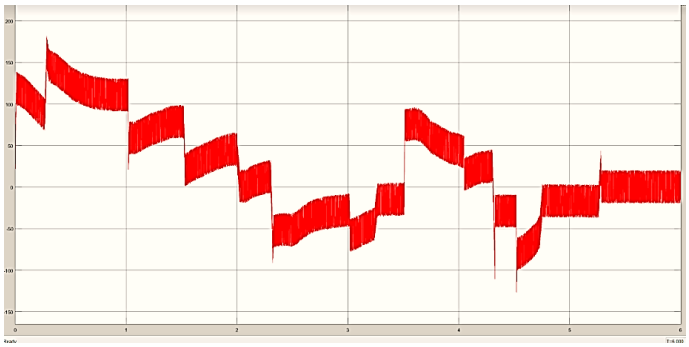

Fig. 7: PI Controller Base Ultra Capacitor Current

It shows high fluctuations in PI controller based ultracapacitor current.

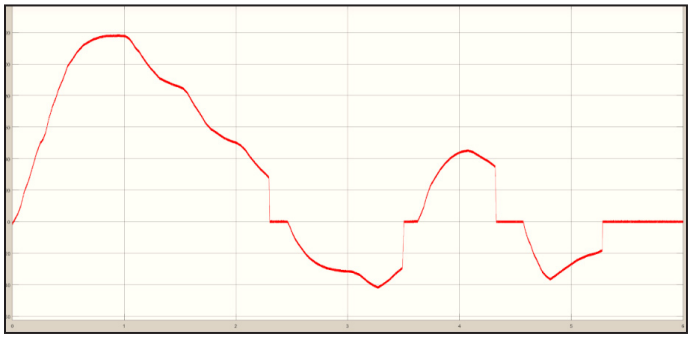

Fig. 8: PI Controller Battery Current
Battery current for PI controller is shown above.

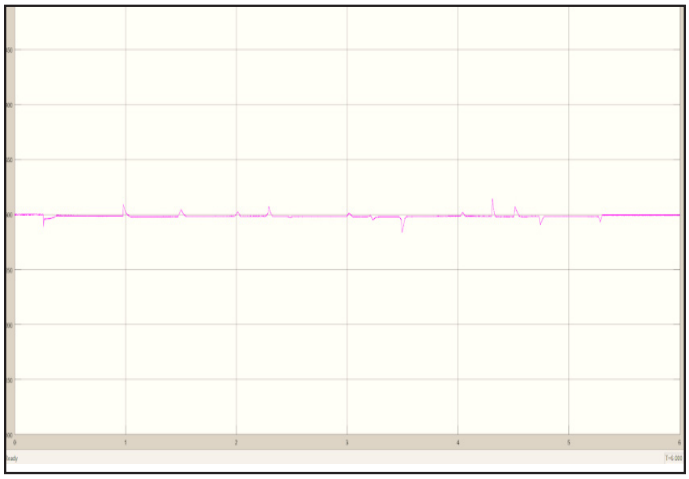

Fig. 9: NNPI Based Output Voltage

Ann-PI based output for voltage DC is shown in above figure.

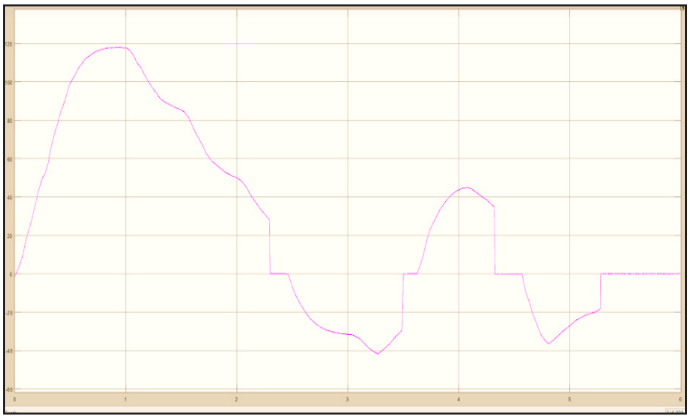

Fig. 10: NNPI Controller Based Battery Current

Above figure shows the battery current output.

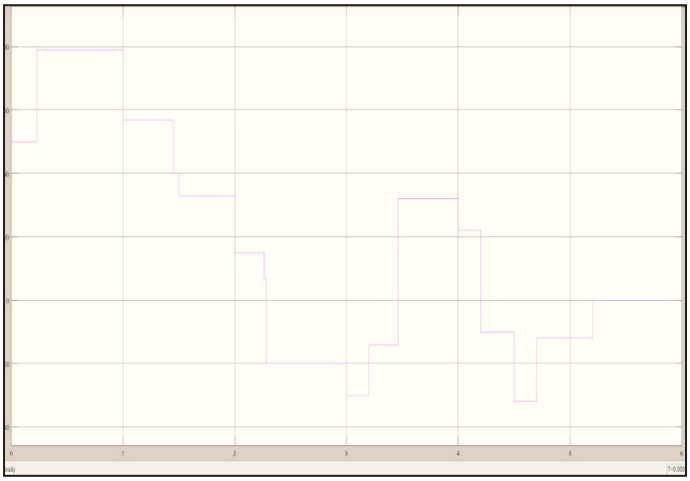

Fig. 11: Load Current

Above figure shows the load current is similar to the existing one.

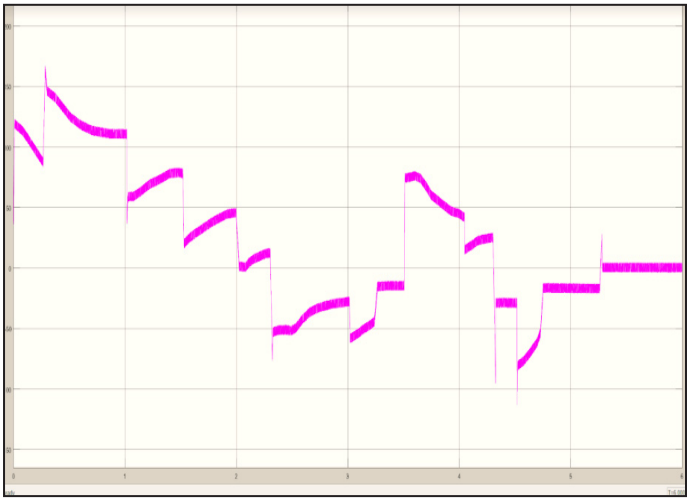

Fig. 12: Iuc using NNPI

The above diagram shows the current for ultracapacitor with lower distortions.

III. Conclusion

It was shown that a NNPI controller may improve the performance of a hybrid energy storage system while also lowering the amount of distortion it produces. Electric Vehicles (EVs) are known for their much lower emissions of carbon dioxide into the atmosphere compared to gasoline-powered automobiles. People consider them to be a potential substitute for Internal Combustion Engines (ICEs). Even while we are unsure of the precise consequences that cutting emissions will have, it is possible that doing so will assist enhance the quality of energy in many different ways. The advantages of reducing carbon emissions are reduced by a significant amount when electric vehicles are charged with electricity from power plants that are dependent on oil. This is due to the fact that a significant amount of power is wasted during the manufacturing process, as well as during transmission, transfer, and charging. Transferring energy straight from a spinning tyre to a stationary battery is one of the most essential methods for an electric car that consumes more power to utilise more energy. This is one of the most critical techniques. When compared to the low-rate capacity of batteries, supercapacitors, which are part of a Hybrid Energy Storage System (HESS), are capable of receiving enormous quantities of current. This might save as much as half of the electricity that would normally be used by the regenerative braking system.

References

[1] Tobias Andersson et al.,"Alternative Energy Storage for Hybrid Electric Vehicles." IEEE AES magazine, 1992, pp. 14–19.

[2] E. Akhavan-Rezai, M. F. Shaaban, E. F. El-Saadany, and F. Karray, "Incorporating Plug-in Electric Vehicles and Solar Panels in LV System Unbalanced Mitigation" IEEE Spec. 112, 2004.

[3] A. Jaya Laxmi and colleagues, "Comparison of PI and ANN Control Strategies for a Unified Shunt Series Compensator." 2006, IEEE.

[4] A. Jaya Laxmi and colleagues, "Comparison of PI and ANN Control Strategies for a Unified Shunt Series Compensator." 2007.

[5] Huilong Yu et al., "Multi-objective Optimization of the Sizing and Energy Management of Hybrid Energy Storage Systems for Electric Vehicles." Cao, IEEE Member, and Fei-Yue Wang, IEEE Fellow, March 2009.

[6] Xiaodong Zhang and colleagues, "A Multi-hybrid Energy System for Hybrid Electric Vehicles." Vol. 4 - ISSN 2032-6653 - WEVA, 2010.

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

[8] Rached Dhaouadi et al., "Controlling the Synergetics of a Hybrid Battery-Ultracapacitor Energy Storage System." IEEE Transactions on Industrial Electronics, 57(12):3917-3926, 2010. IEEE Transactions on Industrial Electronics, 57(12):3917-3926, 2010.

[9] Juan Sebastián Guzmán Feria et al., "Sizing a hybrid energy storage system for use in a power grid." IEEE, vol.100, no.2, February 2012, pp.311,316.

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

[11] Wei Lu et al., "A PID Controller Based on an Artificial Neural Network and a Differential Evolution Algorithm," IEEE Transactions on Control Systems, VOL. 7, NO. 10, October 2012.

[13] Younghyun Kim and colleagues, "Computer-Assisted Design and Optimization of Hybrid Energy Storage Systems." Vol. 7, No. 4 (2013), pp. 247–338, 2013.

[14] Aamir et al., "On substituting an ANN controller for DC motor position control." Month of April 2013.
[15] Georgia Institute of Technology et al., "Nuclear Hybrid Energy System with Molten Salt Storage." November 2013 INL/EXT-13-31768 Revision 0.
[16] M. Gopikrishnan et al., "Battery/ultracapacitor Hybrid Energy Storage System for Electric, Hybrid, and Plug-in Hybrid Vehicles." Middle-East Journal of Scientific Research 20 (9): 1122-1126, 2014. Middle-East Journal of Scientific Research 20 (9): 1122-1126, 2014.
[17] Younghyun Kim et al., "Design and implementation of a scalable and adaptable hybrid energy storage system." 255 410e422, Journal of Power Sources, 2014.
[18] Aarthi et al., "Comparison of Pi, Fuzzy Logic, and Neural Network-Based Control of Doubly Fed Induction Generators in Wind Energy Generation," Vol. 1, No. 6, August 2014.
[19] Vikram Chopra et al., "Comparative Analysis of Tuning a PID Controller Using Intelligent Methods," IEEE Transactions on Industrial Electronics, Vol. 11, No. 8, August 2014.
[20] Y. Sayara et al., "Comparison of the Raspberry Pi and the Ann Controller for Hvdc Link" 2006-2015.