iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 **Issue:** VII **Month of publication:** July 2025

DOI: https://doi.org/10.22214/ijraset.2025.73168

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue VII July 2025- Available at www.ijraset.com

Battery-Supercapacitor Hybrid System for EV Transportation

Srinivasan C[1], Prasanth M[2], Praveen S[3], Srikanth S[4], Vasanth Kumar M[5]
Department of Electrical and Electronics Engineering, RP Sarathy Institute of Technology, Salem, Tamilnadu

Abstract: Electric vehicles (EVs) face challenges in achieving optimal energy efficiency, prolonged battery life, and enhanced power delivery for high-performance applications. To address these issues, this project proposes a Battery-Super capacitor Hybrid Energy Storage System (HESS) integrated with a bidirectional DC-DC converter. The system utilizes a battery for steady energy supply and a super capacitor for high-power transient demands, ensuring better energy management, reduced battery stress, and improved overall efficiency. The ATmega328 microcontroller monitors voltage levels, controls power flow, and optimizes energy distribution. The system also includes MOSFET driver circuits, a voltage sensor, and an LCD display for real-time monitoring. This approach enhances energy utilization, increases the lifespan of the battery, and provides a more sustainable solution for electric vehicle power management.

I. INTRODUCTION

HESS devices have become very essential components of numerous applications involving electric vehicles, renewable energy based operations, energy storing devices etc. A HESS consists of two types of energy sources with different power densities. The main energy source is generally a battery, which can supply a slow varying power demand on the long period of time. A super-capacitor or ultra-capacitor is used as the alternate source, which can supply short burst of energy in a small time interval to deal with fast variations in power demand. The two energy sources can be connected to a common supply bus in a passive or active manner. The main requirement of HESS is to provide a stable power and energy supply for the concerned application. Numerous topologies like passive, semi-active, active interconnection strategies have been proposed, so that a HESS could maintain the output power/ energy amid the load variations.A

II. LITERATURE REVIEW

1) Mesbahi et al. (2019) [1] – "Dynamic model of li-ion batteries incorporating electro thermal and ageing aspects for electric vehicle applications"

Key Points:
Quantitative comparison of energy and power densities.
Proposes configurations for maximizing energy use efficiency.
Relevance: Justifies the hybrid approach based on complementary characteristics.

2) H. Gualous et al. (2010) [2]– "Experimental Study of Super capacitor Serial Resistance and Capacitance for EVs"

Key Points:
Focuses on dynamic modeling of super-capacitors under load.
Examines losses and thermal behavior.
Relevance: Critical for real-world design of hybrid systems

3) Kim et al. (2019) [3] – "Design and optimization of supercapacitor hybrid architecture for power supply-connected batteries lifetime enhancement"

Key Points:
Explores thermal management and size optimization.
Proposes an intelligent EMS based on load conditions.
Relevance: Demonstrates practical implementation strategies.

III. METHODOLOGY

1) Hybrid Energy Storage System Design
- Battery (primary energy source) supplies continuous power for long-term operation.
- Super capacitor (secondary energy source) handles peak power demands and regenerative braking energy recovery.

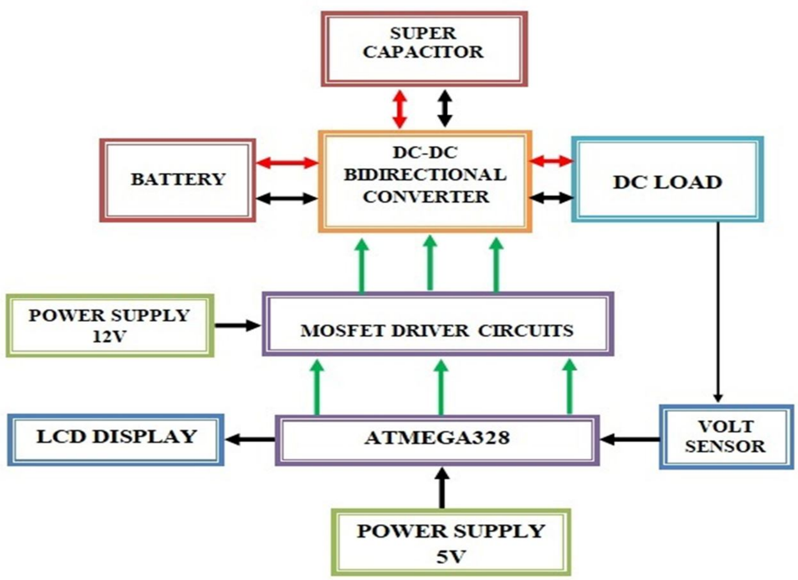
2) Bidirectional DC-DC Converter Implementation
- Allows bidirectional energy transfer between battery, Super capacitor and DC load.
- Ensures efficient energy flow based on demand and availability

3) Microcontroller-Based Control System
- Almega328 controls and optimizes energy distribution.
- MOSFET driver circuits regulate voltage and current.
- Voltage sensor monitors system performance.

4) Real-Time Monitoring and Display
- LCD display shows battery and super capacitor voltage levels.
- Alerts for low battery levels or power fluctuations.

5) Integration and Testing
- Prototype implementation and testing under varying load conditions.
- Performance evaluation for efficiency. stability and reliability.

IV.BLOCK DIAGRAM



V. RESULTS

Experimental Results and Analysis The proposed scheme has been validated by conducting various experiments on designed prototype and it’s results are explored in this section. Initially experiments has been conducted with conventional control scheme and later with the proposed scheme. The experiments have been conducted on a 48 V Li-ion battery with 12V 500 F super-capacitor with a buck boost type dc-dc converter with voltage and current of 50V and 20A respectively.

VI. CONCLUSION

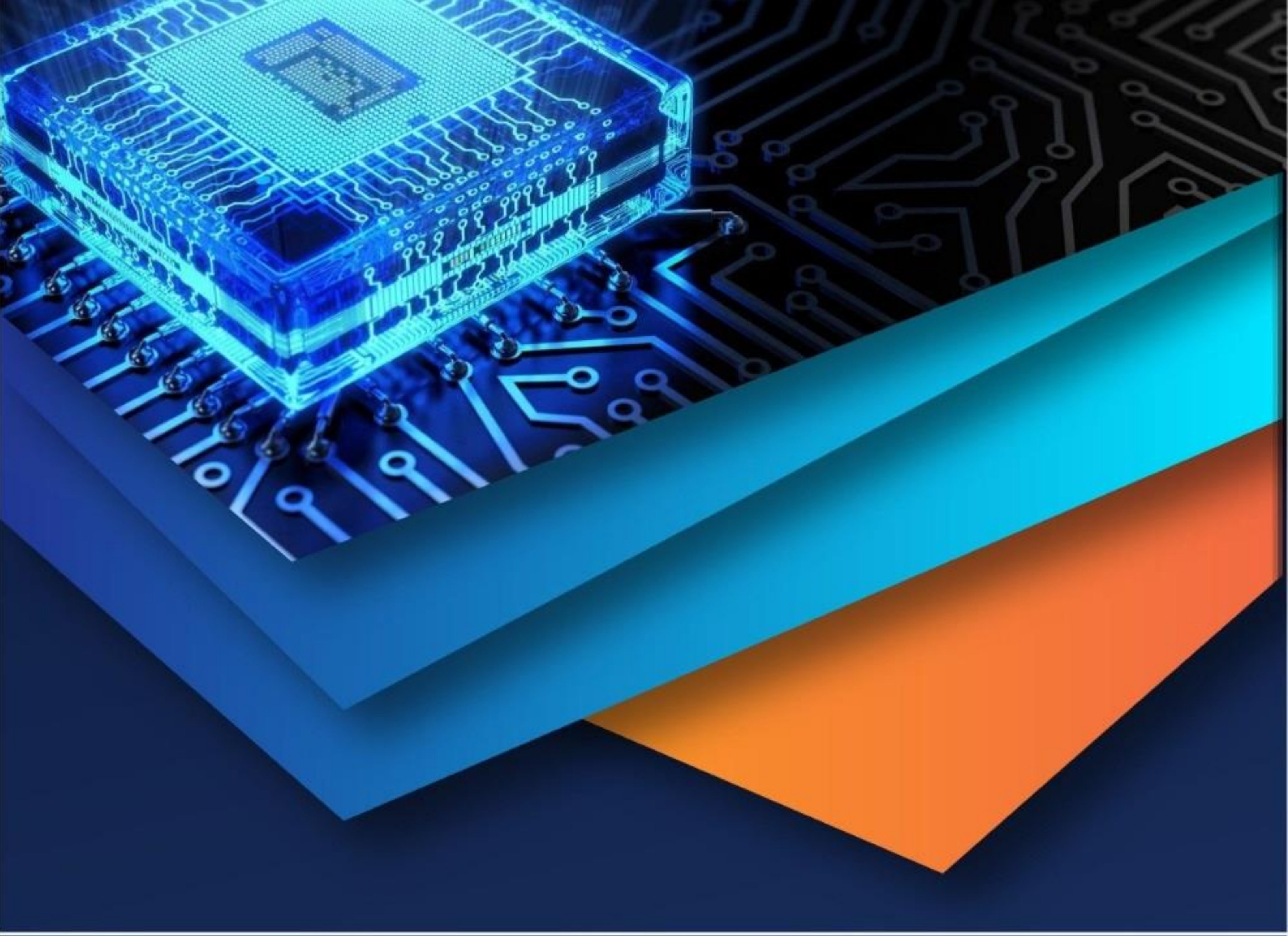
This article proposed an adaptive λ tracking controller for the HESS system comprising an active combination of battery and super-capacitor. The controller is robust against various uncertainties like change in SOC, change in system parameters and measurement noise. Moreover, the controller is simple in structure and does not require intensive computations. The simulations and experiments shows the effectiveness of the proposed scheme. Therefore, the controller may be suitable for practical implementation.

REFERENCES

[1] T. Mesbahi, N. Rizoug, P.Bartholome¨us, R. Sadoun, F. Khenfri,andP. Le Moigne, "Dynamic model of li-ion batteries incorporating electro thermal and ageing aspects for electric vehicle applications," IEEE Transactions on Industrial Electronics, vol. 65, no. 2,pp.12981305,2018.

[2] Gualous, H., Bouquain, D., Berthon, A. and Kauffmann, J.M., 2003. Experimental study of supercapacitor serial resistance and capacitance variations with temperature. Journal of power sources, 123(1), pp.86-93.

[3] Kim, J., Shin, D., Baek, D. and Park, J., 2019. Design and optimization of supercapacitor hybrid architecture for power supply-connected batteries lifetime enhancement. Electronics, 8(1), p.41.



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY