DEVELOPMENT OF SOLAR ROOF SYSTEM TO OVERCOME BATTERY DRAIN IN ELECTRIC VEHICLES (EV)

Project Reference No.: *49S_BE_4163*

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Keywords:
Electric Vehicles (EVs), Battery Drain Reduction, Renewable Energy Integration, Auxiliary Load Management, Smart Energy Management, Prototype Development, Carbon Footprint Reduction, Automotive Innovation, Future Scope in EV Industry

Introduction:

The rapid growth of electric vehicles (EVs) has revolutionized modern transportation, offering a cleaner and more sustainable alternative to fossil fuel–based mobility. However, one of the persistent challenges faced by EV users is the issue of battery drain, particularly when vehicles are idle or when auxiliary systems such as air conditioning, infotainment, and lighting are in continuous use. Frequent charging not only reduces convenience but also places additional demand on charging infrastructure and the power grid.

To address this challenge, the integration of solar roof systems presents a promising solution. By harnessing renewable solar energy, EVs can supplement their battery power, reduce idle drain, and extend driving range. This project focuses on the design and development of a solar roof prototype that channels harvested energy through a DC-DC converter into the battery management system. The innovation lies in dual-mode energy utilization: powering auxiliary loads directly and charging the battery when surplus energy is available.

The prototype employs lightweight, high-efficiency solar panels combined with microcontroller-based monitoring for real-time energy management. Experimental results demonstrate measurable contributions to range extension and improved battery health. Beyond technical feasibility, this project emphasizes sustainability, cost-effectiveness, and industry relevance. It highlights the societal benefits of reducing carbon emissions, lowering charging frequency, and promoting renewable energy adoption in everyday mobility.

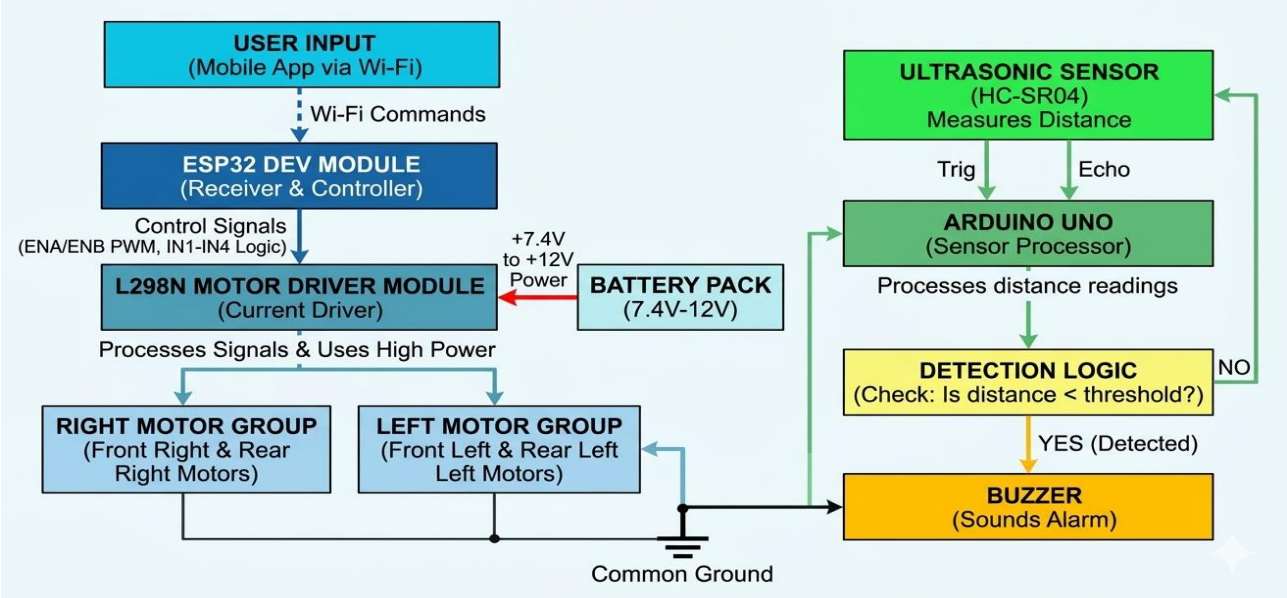

Figure 1: METHODOLOGY AND POWER GENERATING SYSTEM /FLOW CHART

Objectives:

1. To design a solar roof system that can be seamlessly integrated with the EV battery management system using a DC-DC converter.
2. To maximize solar energy capture through lightweight, high-efficiency photovoltaic panels optimized for limited roof space
3. To reduce idle battery drain by powering auxiliary systems directly from solar energy, thereby extending battery life and driving range.
4. To develop a functional prototype with real-time monitoring (Arduino/ESP32) and evaluate performance under varying sunlight and environmental conditions.

Methodology:

1. Designed a solar roof system integrated with EV battery management using a DC-DC converter.Created block diagrams and energy flow models to visualize solar harvesting and distribution.
2. Chose lightweight, high-efficiency monocrystalline solar panels for maximum energy capture.Selected Arduino/ESP32 microcontroller for real-time monitoring and control.
3. Built a small-scale solar roof prototype (~200W capacity).Integrated sensors to measure solar input, battery voltage, and auxiliary load consumption.
4. Conducted tests under varying sunlight conditions (clear, cloudy, shaded).Logged data on energy contribution, battery drain reduction, and auxiliary system performance.
5. Compared prototype results with baseline EV battery performance.Evaluated cost-effectiveness, efficiency, and feasibility for industrial adoption.

Result and Conclusion:

1. The prototype solar roof (~200W) successfully generated supplementary energy under controlled test conditions.

2. Demonstrated reduction in idle battery drain by powering auxiliary systems directly from solar input.
3. Achieved modest range extension (~1–2 km per hour of peak sunlight), validating the concept.
4. Real-time monitoring confirmed stable energy flow and feasibility of integration with EV battery systems.
5. The solar roof system shows promise as a **supportive technology** to mitigate battery drain in EVs.
6. Current results are **proof-of-concept only**; large-scale implementation requires higher efficiency panels and advanced energy management.
7. The prototype highlights the **potential societal benefit** of reducing charging frequency and promoting renewable energy adoption.

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Future Scope:

1. Advanced Solar Technologies – Integration of next-generation solar cells (perovskite, tandem, or thin-film) to significantly boost efficiency and reduce weight.
2. Smart Energy Management – Development of AI-based algorithms for dynamic energy distribution between auxiliary systems and battery charging, optimizing performance in real time.
3. Scalability to Larger Vehicles – Expansion of solar roof systems to buses, delivery vans, and public transport fleets, enhancing sustainability in mass mobility.
4. Industrial Collaboration – Partnerships with automotive OEMs and solar panel manufacturers for large-scale adoption and commercialization of modular solar roof kits.
5. IPR & Commercialization – Filing patents for unique integration designs and energy management systems, with potential to market solar roofs as aftermarket EV accessories.