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REVIEW ON DESIGN OF SMARTFLOWER SOLAR TRACKING SYSTEM FOR EV CHARGING

[1]KUSHARE VIKAS MADHUKAR ,[2]GAIKWAD TEJAS MACHHINDRA ,[3]KALE DARSHAN ANIL
[4]PAWAR PALLAVI GULAB

[1]UG Scholar, Department Of Electrical Engineering ,SND COE and RC Yeola Nashik
[2]UG Scholar, Department Of Electrical Engineering ,SND COE and RC Yeola Nashik
[3]UG Scholar, Department Of Electrical Engineering ,SND COE and RC Yeola Nashik
[4]UG Scholar, Department Of Electrical Engineering ,SND COE and RC Yeola Nashik

ABSTRACT In recent years, countries worldwide have actively advocated electric vehicles for environmental protection. How- ever, restrictions on the driving range and charging have hampered the promotion of electric vehicles. This study proposes a portable, auxiliary photovoltaic power system based on a foldable scissors mechanism for electric vehicles. The system includes a photovoltaic power generation module and an electricity transfer module. The photovoltaic power generation module built based on a foldable scissors mechanism is five times smaller than in its unfolded state, improving its portability in its folded state. The electricity transfer module transfers electricity into the cabin via wireless power transfer units and stores electricity in supercapacitors. Solar simulation exper- iments were conducted to evaluate the system's performance: maximum output power of 1.736 W is measured when the load is 5 Ω, while maximum wireless power transfer efficiency is up to 57.7% with 10 Ω load. An elec- tric vehicle in Chengdu city was simulated for a case study. The results show that the annual output of a single photovoltaic power system can drive the MINIEV for 423.625 km, indicating that the proposed system would be able to supply power for electric vehicles as an auxiliary power supply system.
Index Terms – Auxiliary photovoltaic power system Energy harvesting
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I. INTRODUCTION

Environmental pollution and climate change caused by the overuse of fossil fuels forced humankind to look for renewable energy sources. As an indispensable part of contemporary society, the transportation sector is responsible for more than one-third of the total CO_2 emissions [1]. Electric vehicles (EVs) are an excellent solution to reduce the trans- portation sector's carbon emissions [2]. However, the driving range lim- itations due to battery capacity and charging station are two challenges researchers have attempted to overcome.

There are two ways to achieve the range extension of EVs: one is to supply power to the vehicle sensors and other equipment to reduce the burden on the EVs' battery, thus achieving the purpose of range exten- sion; the other is that the electricity generated is used directly to extend the range of the EVs. Many researchers have shown great interest in re- newable energy harvesting to extend the range. Nowadays, more and more energy regenerative technologies are proposed to harvest ambient energy, such as kinetic energy, solar energy, and sound energy, to power EVs.

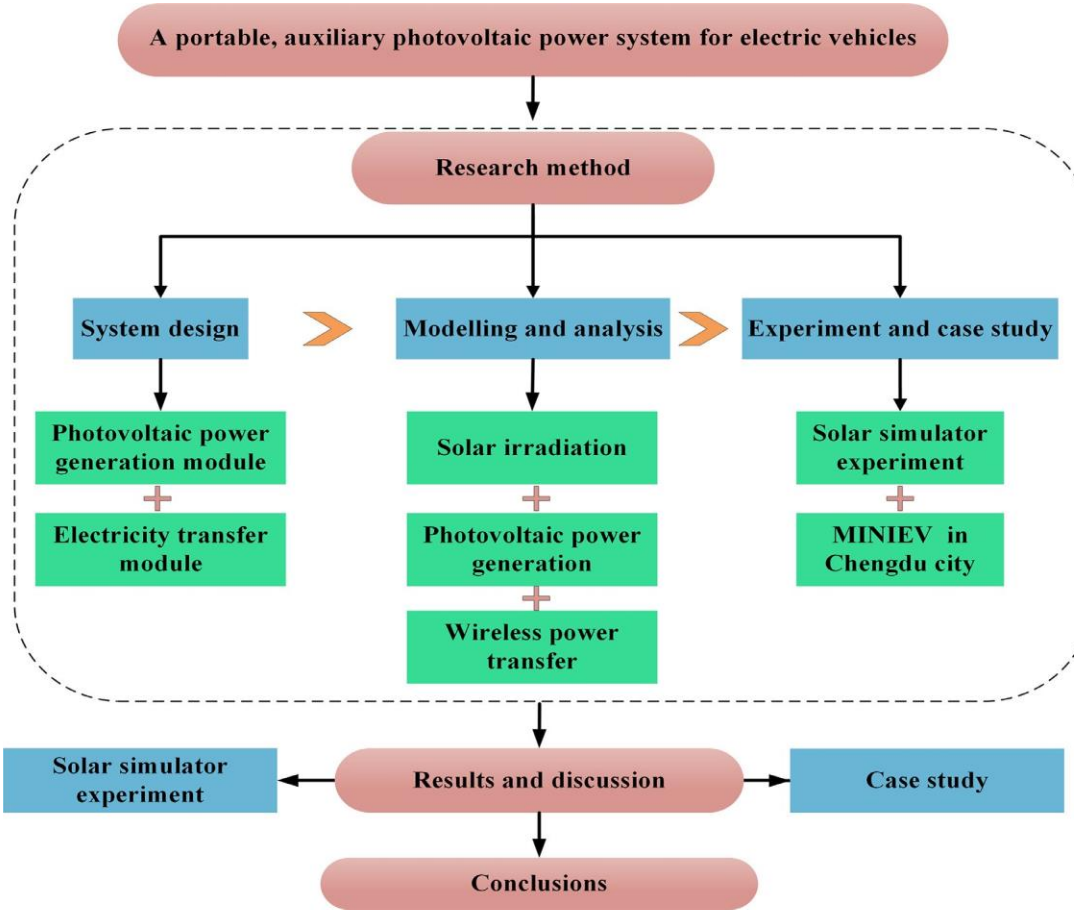

Fig. 1. The flowchart of this study.

II. RESEARCH METHOD

2.1 System design

In order to increase the range of EVs and consider the advantages and disadvantages of existing energy harvesting technologies, this paper proposes to use photovoltaic power generation to charge EVs. An auxiliary photovoltaic system combined with WPT is proposed to use solar energy resources to extend the range of EVs while considering the portability and versatility of the photovoltaic system. The overall struc- ture and working principle of the auxiliary photovoltaic power system for EVs are presented in The designed system consists of two main parts: a PVPGM and an electricity transfer module.

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The foldable PVPGM is the power generator of the auxiliary power system, and it is manually mounted on EVs parked outdoors. Equipped with solar cells, the PVPGM—based on a foldable scissors mechanism—is designed to improve portability. Specifically, the PVPGM has a larger area in its unfolded state; when the PVPGM is not working, it can be folded and stored inside the EV to improve space utilization without affecting nor- mal driving. The second part is the electricity transfer module, by which the electricity generated by the PVPGM is transferred into the cabin through WPT units. The electricity is stored in a supercapacitor, which can be an extra power source for the EV. Before driving, the PVPGM should be folded and placed inside the EV

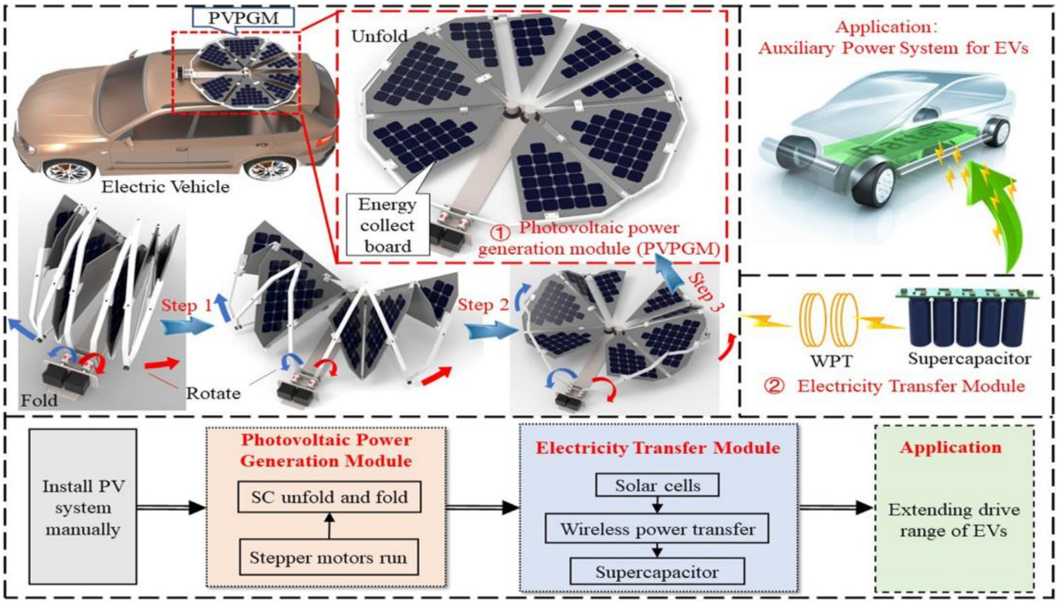

Fig. 2. System diagram of the proposed auxiliary photovoltaic power system.

III. Conclusion

This paper designed a portable, auxiliary photovoltaic power sys- tem based on a scissors mechanism for electric vehicles. The developed power system includes a photovoltaic power generation module and an electricity transfer module. The photovoltaic power generation module is designed to improve portability based on the scissors mechanism, and wireless power transfer technology is applied to transfer electricity. The solar simulation experiment shows a maximum output power of 1.736 W and a maximum electricity transfer efficiency of 57.7% with loads of 5 Ω and 10 Ω, respectively. Based on the case study results, the annual electricity generated by the proposed auxiliary power system is 2.033 GWh. The power generated by the PVPGM, good performance of wire- less power transfer, and case study shows that the proposed auxiliary power system has great potential for powering electric vehicles.

This study proposed the concept of using a portable, auxiliary photo- voltaic powering system for electric vehicles and verified its feasibility, but there are still contents for further research. Future work will consist of placing the photovoltaic power generation module in natural sunlight

for a longer period to verify its robustness. The area of the proposed pho- tovoltaic power generation module is relatively small, only 0.47 m^2, while a car usually occupies more than 10 m^2; therefore, the area of the photovoltaic power generation module can be increased to generate higher output power for electric vehicles. To further improve the power generation efficiency of the proposed photovoltaic power system, the next research will be carried out in two aspects: maximum power point tracking technology and low-power, high-accuracy solar tracking tech- nology.

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