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DesignandAnalysisofSolar-PoweredElectricVehicleStation

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ABSTRACT:ThispaperpresentsanintegratedapproachthatcombinesMATLABsimulationand hardwaredesignforthedevelopmentofefficientandreliablesolarcharging stations. The MATLAB simulation model analyzes crucial parameters, includingsolar panel characteristics, battery capacity, and user demand, to optimize the behavior andperformance of the charging station. Utilizing the insights gained from the simulation, ahardwareprototypeisdesignedandconstructed,incorporatingsolarpanels,powermanagement systems, and user-friendly features. The iterative process between simulationand hardware design enables continuous refinement and enhancement, resulting in thedevelopmentofoptimizedchargingstations.Thismethodologycontributestotheadvancement of sustainable charging infrastructure by seamlessly integrating MATLABsimulationandhardwaredesign,providingacomprehensivesolutionforeffectiveutilization of solar energy in charging stations. The findings presented in this paper offervaluable insights for researchers, engineers, and practitioners involved in the design andoptimizationofsolarcharging stations.

Keywords:Solar-PoweredElectricVehicleStation, **batterycapacity**

1. 1.INTRODUCTION
2.

Theincreasingdemandforportableelectronicdevices,coupledwiththegrowingemphasisonsustainability, has led to a rising need for efficient and eco-friendly charging solutions. Solar chargingstations have emerged as a promising solution, harnessing the power of the sun to provide clean energyforchargingvariousdevices.Tomaximizetheperformanceandeffectivenessofsolarchargingstations, anintegratedapproachthatcombinesMATLABsimulationandhardwaredesignisessential.Theintegration of MATLAB simulationallows fora thoroughanalysis and optimizationofthe charging station's behavior and performance. By considering critical parameters such as solar panelcharacteristics, battery capacity, and user demand patterns, the simulation model provides valuableinsights into system behavior, power utilization, and charging efficiency. This enables engineers andresearchers to fine-tune the design and operation of the charging station, ensuring optimal performanceand energy utilization. Complementing the simulation model, the hardware design aspect focuses ontranslatingthesimulationinsightsintoapracticalandfunctionalchargingstation.Throughtheselection and integration of solar panels, power management systems, and user-friendly features, thehardware prototype is designed to meet the specific needs of users while ensuring efficient and reliablecharging.

The iterative process between simulation and hardware design allows for continuous refinement andenhancement, enabling the development of an optimized solar charging station. The integration ofMATLABsimulationandhardwaredesigninthiscontextcontributestotheadvancementofsustainablecharginginfrastructure,offeringacomprehensivesolutionforeffectiveutilizationofsolar energy in charging stations. In this paper, we present the integrated approach of MATLAB simulationand hardware design for the development of efficient and reliable solar charging stations. We discussthe importance of this approach in optimizing the performance and sustainability of charging stationsandhighlightitspotentialinmeetingthegrowingdemandforcleanandaccessiblechargingsolutions.

3.

2. **LITERATUREREVIEW**

4.

Solar charging stations have gained significant attention in recent years as sustainable alternatives forpowering portable electronic devices. This section presents a literature review on the topic of solarcharging stations, withaspecificfocus onthe integrationofMATLAB simulationandhardwaredesign. Several studies have explored the optimization of solar charging stations using MATLABsimulation. Singh and Singh (2017) investigated the impact of varying solar panel tilt angles on energygeneration and developed a MATLAB simulation model to identify the optimal angle for maximumpoweroutput.Similarly,Ahmadetal.(2019)employedMATLABsimulationtoanalyzetheperformance of different battery technologies in solar charging stations, aiding in the selection of themost suitable battery type for maximizing energy storage and utilization. In terms of hardware design,Li et al. (2018) proposed a solar charging station prototype that integrated MPPT (Maximum PowerPoint Tracking) techniques for improved energy conversion efficiency. Their work demonstrated theeffectivenessofhardwaredesigninenhancingtheperformanceandreliabilityofsolarchargingstations. The integration of MATLAB simulation and hardware design in the development of solarcharging stations is an emerging area of research. Chen et al. (2020) presented a comprehensiveapproachthatcombinedMATLABsimulationwithhardwaredesigntooptimizethedesignand operation of a solar charging station. Their study highlighted the importance of iteratively refining thesimulation model and hardware prototype to achieve an efficient and reliable charging system. WhileexistingliteraturehasexploredvariousaspectsofsolarchargingstationsandtheintegrationofMATLAB simulation and hardware design, there is a need for further research on optimizing thecharging efficiency, scalability, and user experience of these systems. This paper aims to address theseresearch gaps by presenting an integrated approach that combines MATLAB simulation and hardwaredesign forthedevelopmentofefficientandreliablesolarcharging stations.

5.

6. **3.SYSTEMANALYSIS**

3.1 PhotovoltaicEnergy

The relatively simple technology called photovoltaic (PV) converts sunlight directly into electricity.Photovoltaic energy is another renewable energy source, similar to wind energy, which is gainingprominence in the world electricity generation market. The drawbacks of this system are chiefly thehigh initial installation cost and the relatively low energy conversion efficiency. With the developmentof technology, the cost of solar arrays is expected to decrease continuously in the near future makingthemattractive for residential and industrial applications. The basiccomponents of a solarelectricarray as shown in fig. 1.1 are the photovoltaic panels. A group of 36 PV cells, each with an outputvoltage of 0.6V forms a single module. These individual modules are combined in series and parallelpatternstoformapanel oranarray

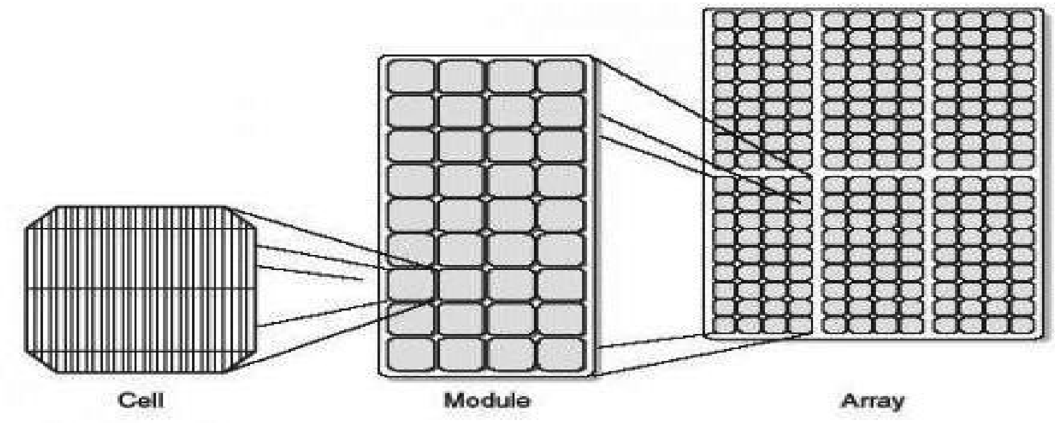

Fig.1.1Photovoltaicmodule

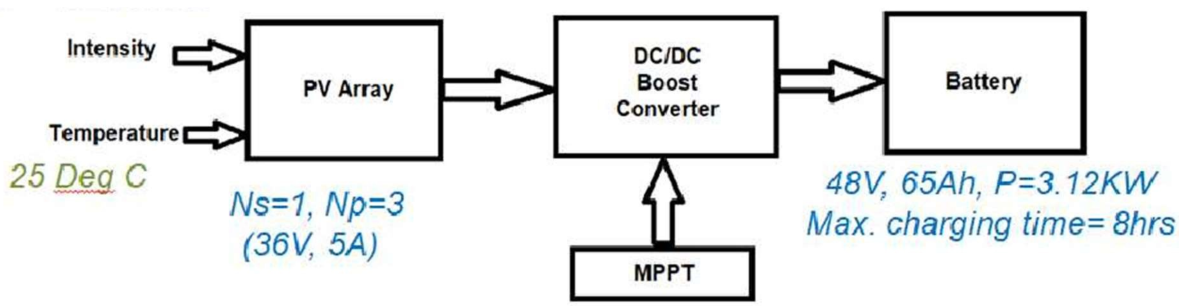

Fig.1.2BlockdiagramofSolarpoweredEVchargingStationmodule

3.2 SolarpoweredEVchargingstation

Solar-powered EV charging stations consist of solar panels installed on the station's roof or in nearbyareas,suchasparkingcanopiesorground-mountedarrays.Thesepanelsconvertsunlightintoelectricity through the photovoltaic (PV) effect. The generated electricity is then used to charge electricvehiclesconnectedtothe chargingstation.

Thesechargingstationsaretypicallyequippedwithcharginginfrastructure,includingchargingconnectors, cables, and control systems. The charging connectors may vary depending on the regionand the type of electric vehicles supported, such as AC (alternating current) or DC (direct current)connectors. In conclusion, solar-powered EV charging stations represent an innovative solution at theintersection of renewable energy and sustainable transportation. They leverage solar power to chargeelectricvehicles, reducingcarbon emissionsandpromotingagreenerandmoresustainablefuture.

3.3 BatterySystem

Battery's open circuit voltage (OCV) is also known as the nominal voltage. It is the voltage potentialthat a battery can produce without being charged or loaded. Battery's open circuit voltage per cell istightlyinvolvedwithitsstateofcharge.Generally,alithium-ionbatteryhasaratedvoltageof3.6V/cell to 3.7V/cell, and a cut-off discharge voltage of 2.75V/cell. The LIR14500 battery utilized inthisproject providesa nominalvoltageof3.7V/cell.

3.4 charger

In this section, we are going to discuss about the integrated simulation model of Solar panel, DC/DCconverter along withMPPTalgorithmwithLi-ion batterypack.The hardware prototype is beendeveloped and their results are displayed.From the characteristics of the Li-ion battery, to charge abattery of 48V, atleast we have to maintain a voltage of 54 to 57 at the input terminal of the battery andalso it should be constant. Suitable capacitance filters and diodes are used at input and out stages of theboostconverter.

SimulationResults

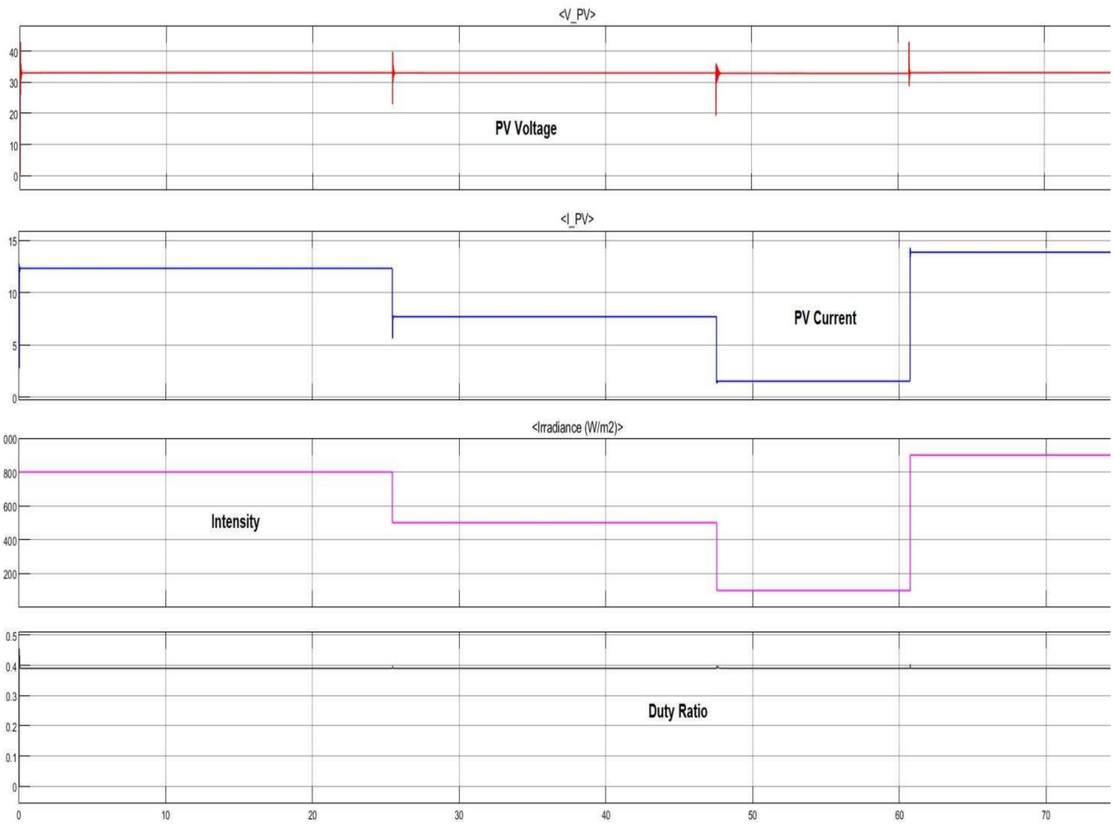

Figure:SimulationresultsshowsPVOutputvoltage,PVOutputcurrent,IntensityvariationandDutyratio

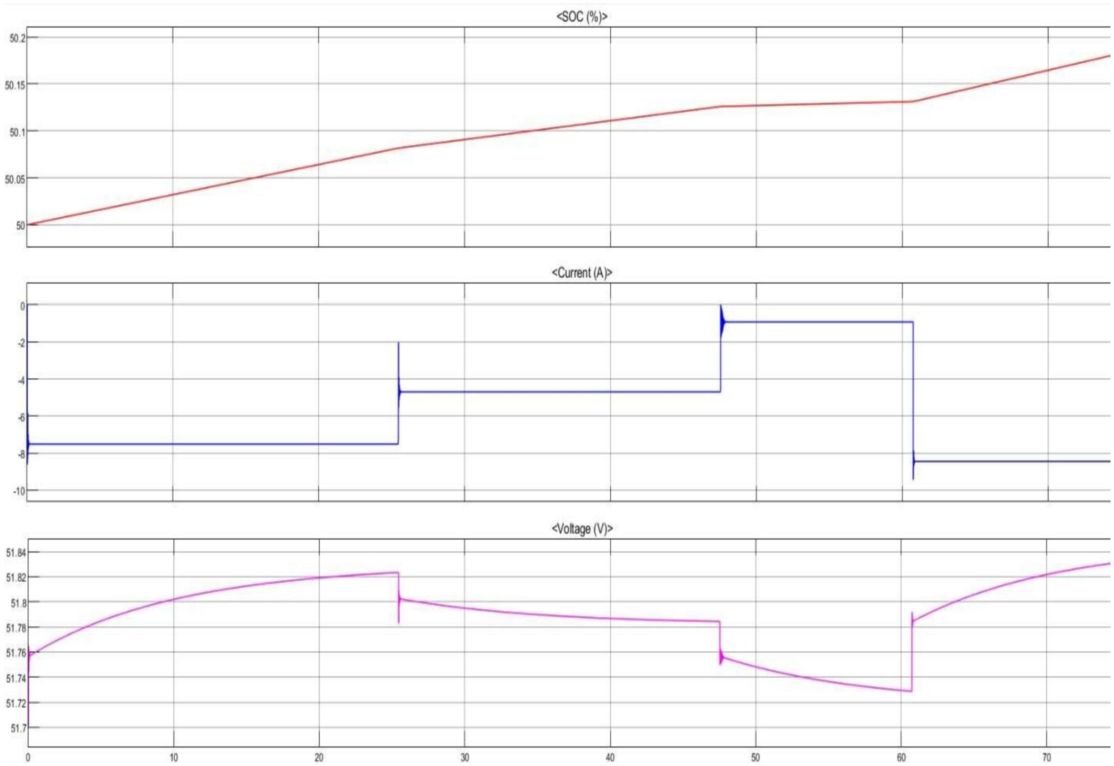

Figure6.3:Simulationresultsshowsoutputvoltage,currentand SOCof48V,65AhLi-ionbattery

Fromthe simulation results it's seen that, for change in variation of intensities, the output voltage ofthe PV array is constant and only the current varies. With the help of MPPT technique, we are able toobtain the maximum power from the solar panel and converted to twice the output of the boostconverter. The duty ratio variation is automatically done by the P and O algorithm. The battery SOC isseen clearly that the slope of charging is steep when the intensity is high. The corresponding currentvariationandvoltagevariationisobserved.Thecurrentisthedisplayisnegativeatthebatteryend,soit clear shown that the battery is charging. The below tabulation clearly shown the parameters that arevaryingastheintensityvaries.

Table6.1:VariationofChargingCurrentforvariationinIntensity

Intensity (W/m2)	V_pv (V)	I_pv(A)	C_time(hr)	V_batt(V)	C_batt(A)
800	36.3	12.5	4.16	52	-7.8
500	36.1	7.5	6.9	51.8	-4.6
100	36	1.7	29.5	51.6	-1.2
900	36.5	14.3	3.6	52.3	-9.6

Conclusion

A standalone Electrical Vehiclecharging station based on a Photovoltaic energysourceis proposed.ThesystemcontainsaPVpanels,boostconverter,buckconvertor,bidirectionalconvertor,ESSbatteries, and the Electrical Vehicle batteries. The control system is combination of four controllers,MPPT, EV charger, and the storage converter controller and A capacitor is added to regulate the batterycurrent during charge and discharge operations, and the reference value of the current is positive forcharging operations, and negative value for discharging operations. The system is built separately inMATLAB Simulink as every convertor is been built and tested alone, and we got an excellent outcomefor every single convertor, the second we aggregate the components to a whole system the results wentvery far from accepted, we changed and calculated the capacitors, inductors, and resistors all over againtillwe gotthe desired outputshowninthispaper.

FUTUREWORKS:

- Developmultiplechargingstationswithbothgridandsolarintegrated
- DevelopwirelesschargingcircuitwithIOTapplication
- Todevelopsolartrackingsystemformaximumpowertracking
- To develop grid connected solar integrated charging station for cost reduction and fasterrecovery ofinstallationcost

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