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Maximum Power Point Tracking for Photovoltaic Systems Operating Using hybrid of SSA&PSO

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Abstract: Due to the physical properties of the network components, energy and power losses occur when electrical energy is transported from generating facilities to customers via transmission and distribution networks. These losses are unavoidable in the transmission of electrical energy through physical channels. Existing networks and planned additions provide a great opportunity to increase energy efficiency. Improving efficiency entails putting in place measures beyond the activity's current best practices in terms of efficacy. To decrease network losses, various practical procedures and technologies may be employed. Salp Swarm Algorithm (SSA) and Particle Swarm Optimization (PSO) The performance study of hybrid energy storage systems (HESSs) reveals various benefits, including a low component count, ease of management and complete control of source energies. An energy management plan must properly estimate the power levels of sources in these systems (EMS). This work provides an energy management system (EMS) for a battery/ultra-capacitor (UC). By using an MPPT controller, the UC state-of-charge is not only smoothed but the battery power profile is also smoothed. As a result, it produces a HESS that is more durable and has longer battery life.

Keywords: energy management system(EMS), Particle Swarm Optimization (PSO), hybrid energy storage systems (HESSs) , Maximum Power Point Tracking (MPPT), Salp Swarm Algorithm (SSA), Solar , ultra capacitor

I Introduction

Electricity is the most important commodity in any country or country's social and economic development. It plays an imperative role in all human behavior in the current situation. The majority of electricity comes from fossil fuels such as coal, oil or natural gas. These fossil fuels have a serious impact on the atmosphere in many ways. Even these fossil fuels are limited and will continue until the middle of this century. Need to implement renewable energy (RES) for green energy

Solar radiation: Solar radiation, also known as insolation, is made up of two types of radiation: radiation that comes directly from the sun (beam radiation) and radiation that arrives indirectly from the sun (diffuse radiation) (diffusion and albedo radiation). The solar constant is defined as the amount of solar radiation that falls on a unit region of space above the atmosphere when the sun is shining vertically. It has a power density of 1367 W/m2. The amount of sunlight absorbed in the atmosphere is measured by the air mass, which is a handy lumped parameter. One air mass is defined as the quantity of beam solar radiation absorbed in the atmosphere on a direct vertical path to sea level in a given time period (AM1).

At around 0.5 V DC, a typical PV cell provides less than 2 W of power. In order to achieve the needed power and voltage ratings, it is necessary to connect PV cells in series and parallel configurations. Single photovoltaic cells are grouped together to form modules, which are then coupled together to form arrays. Neither the size of a module nor the size of an array are defined in any way that is rigid. The power output of a module might range from a few watts to hundreds of watts depending on the model. Furthermore, the power rating of an array might range from a few hundred watts to several megawatts.

Battery Bank Modeling and Sizing: Developing a Model and Sizing a Battery Bank: The output power of the wind turbine fluctuates throughout the day in accordance with the variations in wind speed. Aside from that, the maximum power output of the PV generator varies depending on the amount of solar radiation and temperature received. Thus, the PV generator and wind turbine may not be able to meet all of the demands placed on them at any given time. During these periods, a battery connected between the hybrid system's DC bus and the load will compensate for the loss of power and serve as a power supply. When the output power from the wind turbine and the PV generator exceeds the load requirement, excess energy is stored in the battery, which can be used to supply load when the wind turbine and the PV generator are unable to do so.

Conventional capacitors store energy by physically separating unlike charges on two separate electrodes with a dielectric in between. This charge separation causes a potential between two electrodes. Ultracapacitors, on the other hand, do not make use of the electrolyte in the same way. A significant charge separation is achieved by the use of electric double layer technology, resulting in extremely large capacitance. In Figure 1.8, you can see that they are made by two metal electrode foils that have been coated with activated carbon, which are immersed in an electrolyte and separated by a paper separator.

Electrons collect in the electrode that is connected to the negative terminal and attract positive ions from the electrolyte as a result of the electrostatic attraction. Positive charges attract negative electrolyte ions on the other electrode, and current flows via the external load on the other electrode. The separator prevents current from flowing directly between the two electrodes and creates the appearance of two charge layers, which is why ultracapacitors are also referred to as electric double-layer capacitors when they have two charge layers.

Since the electrodes are made of a porous material, the charge can be stored in the micro- pores at the electrode and the electrolyte interface. Moreover, the electrode surface is significantly larger than a normal capacitor reaching 2000 $m2/gr$ [16]. This combination of large surface and small separation between electrodes enables capacitances to reach thousands of farads. This structure has major implications on the properties such as cycle life, efficiency, energy and power density, and voltage as a function of SOC.

Being able to release a significant amount of physically stored electric charge makes them extremely high-power sources. Although power density is exceptional, energy density is low since chemical reactions do not bind electrons. This lack of chemical bonding also implies that the ultracapacitor can be completely discharged. Consequently, ultracapacitors will experience larger voltage swings as a function of the state of charge. Figure 1.9 depicts the linear dependency of ultracapacitor voltage to its state of charge.

II RELATED WORK

M. Zeeshan Tariq et al. (2021) In response to the global contribution of renewable energy storage systems (RES), we have noticed an undeniable surge in marine electrical systems. On the other hand, to address the intermittent RES. A battery energy storage system is built into the system. However, the problem is that the energy density is low and the lifespan is short, which increases the space required and increases the cost. To solve this problem, it is recommended to equip an ultra-capacitor battery energy storage device. Therefore, the integrated system provides greater dynamic performance using relatively less space and higher energy. In order to take advantage of these advantages in this integrated system, it is necessary to realize the optimal management of power generation and consumption. This requires the development of accurate and robust control algorithms. This paper proposes an effective control technique in which a PV-powered hybrid energy storage system (HESS) integrates with a conventional diesel generator to supply power to marine loads, primarily lighting and heating. In addition, various possible operating modes for realizing optimal performance given the inconsistency of PV generation are described and verified using simulation results. Meanwhile, some of the major contributions of the proposed control scheme are maximum power extraction from PV panels, power factor single operation of the utility grid and improved reliability of connected loads.

Chen Zhao et al. (2020) As part of a battery's supercapacitor hybrid energy storage system (UC), this study examines equivalent series resistance (ESR) based controls, or circuits, that efficiently disperse the load (HESS). We advocate for a level playing field. The first step is to develop an exemplary capacitor semi-active HESS ESR circuit model in order to demonstrate energy loss at both the circuit and system levels. It has been determined that the overall energy loss of HESS is solely dependent on the percentage of total dynamic load given by the battery pack, as determined by the analytical results. Depending on the load distribution indicated by the percentage of the battery pack's ESR in the total ESR of the UC pack as well as the total ESR of the dc-dc converter, this energy loss can be avoided. Following that, we create an ESR-based real-time control technique to reduce energy loss while also adjusting the UC state of charge (SOC) to prevent overcharge and overdischarge of the battery. As a result of the suggested ESR-based control, both simulation and experimental findings demonstrate that it is effective in improving energy efficiency, enabling the use of UC packs, and decreasing the temperature rise of the battery. When used in conjunction with ESR-based control, performance is very similar to that of optimal dynamic programming. Under control based on the suggested ESR, the total energy loss and battery temperature rise of the HESS example are decreased on average by 44.9 percent and 51.9 percent, respectively, when compared to the battery-only system.

III PROPOSED

This proposed EMS regulates the state-of-charge of UC and smooths the battery power profile by using an MPPT Controller. Therefore, it results in a sustainable HESS with longer battery life. Through a simulation study and an experimental setup including a real EMS, the performance of the proposed system is evaluated comprehensively. Then, based on experimental results, battery cycle life improvement due to the battery/UC hybridization is explored as stated above. Utilizing both a battery and a UC as a hybrid storage solution has many benefits.

This Hybrid (Battery / UC) storage solution can be classified according to system configuration. Thus, the UC has a certain upper voltage limit since the battery voltage determines the capacitor array size. In addition, the power enhancement is limited due to the current sharing between the battery and UC, according to the internal resistances of each component. The storage system terminal voltage follows the battery discharge curve, varying between fully charged and fully depleted. In UC-battery HESS, the two ESS devices can be coupled to either a common DC or AC bus. For standalone renewable Microgrid, a common DC bus is the preferred choice because most renewable energy sources operate in DC, and no synchronization is needed, which minimizes the system complexity. The system responses are studied using the MATLAB Simulink platform. Finally, PSO and SSA techniques are applied to tune the FOPID controller to control the system frequency and maintain the power balance in the proposed system. The results interpret the superior performances of SSA over PSO. The study reported system stability within accepted system frequency limits during both the source and load variations.

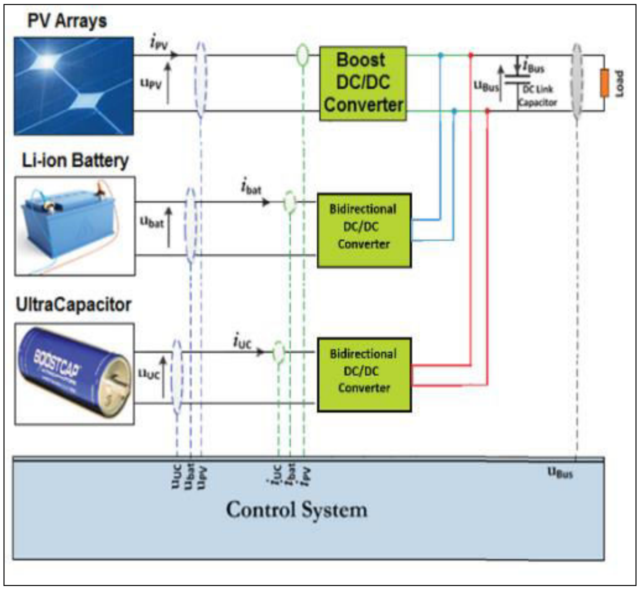

Figure 4.1: Proposed Block Diagram

Each block from Figure .2 was modelled in MATLAB/Simulink. The schematic of the boost converter. The input to the boost converter is the PV output voltage, and the output is the DC link voltage. The control input is a PWM signal generated based on the P&O controller. Voltage and current sensors are utilized to measure the change in power, which is the control feedback term. Optimizing an autonomous photovoltaic system with storage is crucial as the photovoltaic panels are the only generation source. The system optimization is performed on an annual basis to minimize the system lifetime cost under several constraints. The constraints employed in the optimization include the battery SOC limit, restrictions on component dimensions, and an LPSP limit. The input data required for the optimization include the annual solar radiation and the load profile.

The storage system is utilized as an energy buffer to supply power to the load at night time and during periods of low solar radiation. The extent of the storage elements required to supply the load throughout the year fluctuates depending on the number of photovoltaic panels installed in the system. The quantity of photovoltaic panels is varied from the best to the worst case. The storage system is optimized based on the power available to charge the storage elements and the load power required from the storage system. In the HESS, the ultracapacitors are employed to supply the peak power requirements of the load with the average power supplied by the battery bank.

The optimization of the reactive energy compensation is to be understood as the choice of the powers of the capacitor banks, their locations and even the time during which they will remain in line if it is an adaptive compensation. Of course, these choices must be made so that there is the least power loss in line and an improvement in the voltage profile while having a positive economic return. The choices of the objective function are dictated by the concern to take into account both the electrical and economic aspects of the problem. The objective function, over which all authors are involved in the issue of advancing responsive vitality remuneration, is the purported monetary bring capacity back (saving function). However, since the installation of capacitor banks reduces active losses and reactive power losses, unlike all the authors who dealt with a problem of concern, this article will introduce the objective function of reducing reactive power losses. Therefore, the goal is to determine the battery capacities and their location in order to minimize power losses, improve the voltage profile and thereby increase the throughput of these lines.

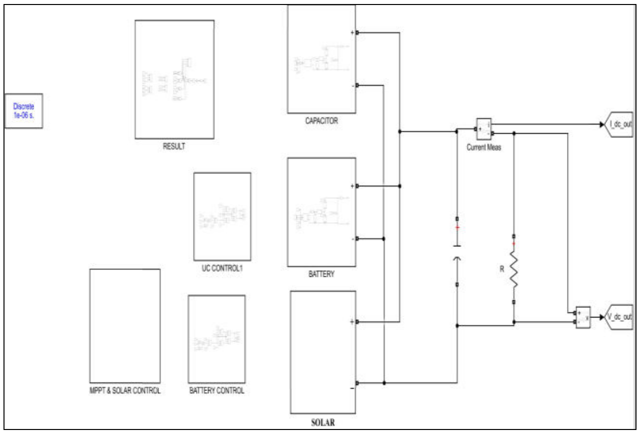

Figure .2: Simulink Model

Simulation Results:

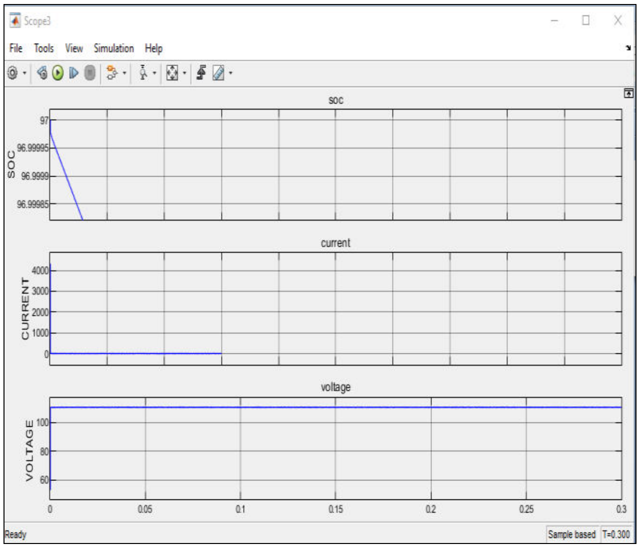

Figure3: Battery Output

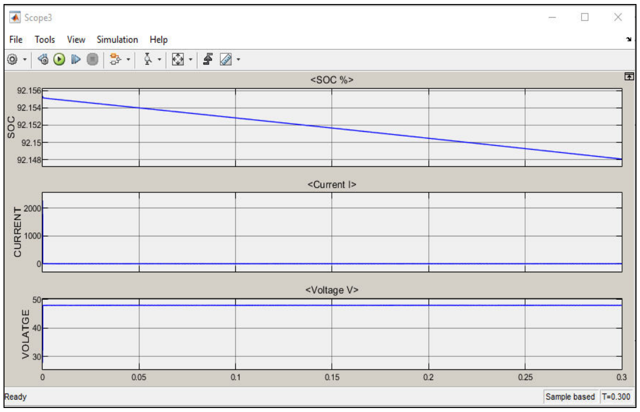

Figure 4: Capacitor Output

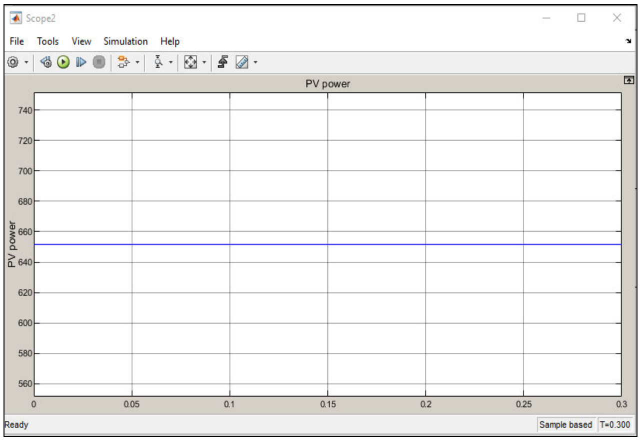

Figure 5: PV Power

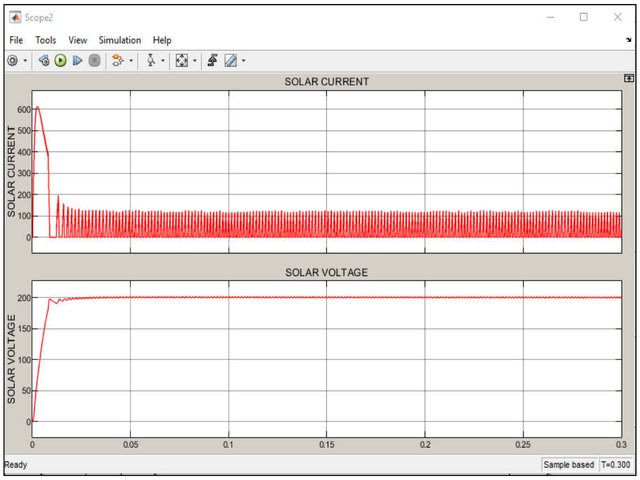

Figure 6: Solar Voltage and Solar Current

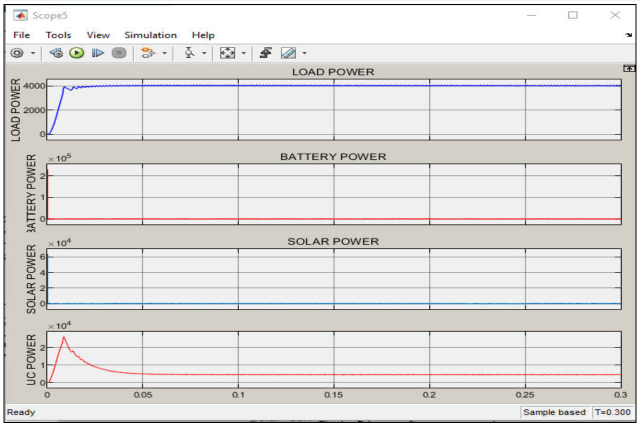

Figure 7: Load Power, Battery Power, Solar Power

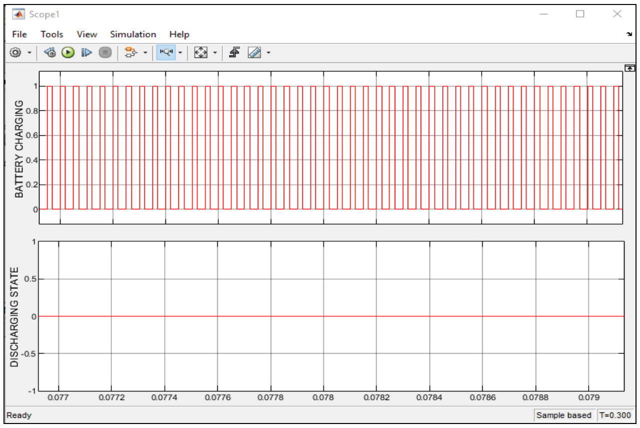

Figure 8 Battery Charging and Discharging

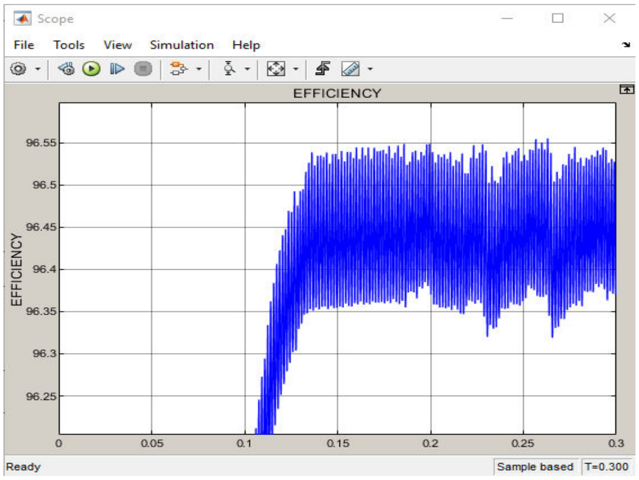

Figure 9: Efficiency of The System

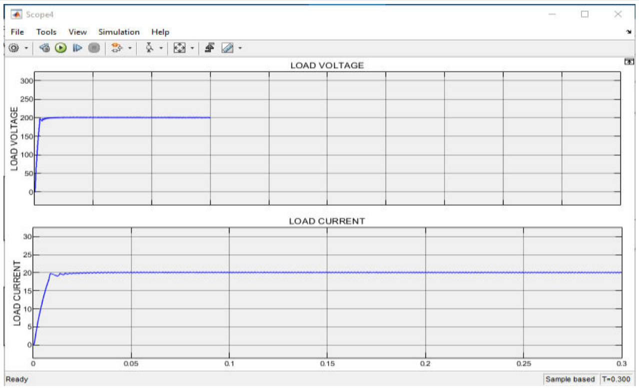

Figure 10: Load Voltage and Cu

Conclusions

This thesis is based on an energy management strategy (EMS) for a battery/ultracapacitor hybrid energy storage system (HESS) that has been presented in this work. The HESS is composed of a bidirectional non-isolated multi-input dc-dc converter which can achieve power flow between each input source and output port. An EMS has been designed for controlling the SOC of UC while smoothing the battery power profile. By applying this EMS, it aims to ensure the practicability of the hybrid system and decrease the battery power peaks, thus extending the battery cycle life. A sustainable energy system consisting of a photovoltaic array with a battery ultracapacitor HESS to supply a non-grid connected load was introduced. The impact of including the ultracapacitor in the photovoltaic system was analyzed. The batteries and ultracapacitors complement each other in their power and energy densities. Electrical loads that contain motors can have power spikes of between three and seven times their rated wattage at start-up, while loads requiring large capacitors to be charged at the start-up can result in a power surge up to three times their rated wattage. THIS THESIS ANALYSED a DC system, but the same principles apply to AC systems. In an AC system, the inverter must be sized to consider the starting power requirement of the load, with the battery bank being sized to handle the voltage drop due to the high current surge. Otherwise, the voltage drop could cause the inverter to shut down. Depending on the discharge rate. Peak power loads requiring high power reduce the battery capacity, resulting in a voltage drop.

This thesis may assist microgrid operators in making judgments, investing heavily in rural electrification, developing a competitive hybrid microgrid, and optimising energy dispatches. Furthermore, for micro grid system engineers, this study enables preliminary design and project cost projection.

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