Analysis of The Characteristics of Solar cell array in Solar Unmanned Aerial Vehicle

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ABSTRACT

In this paper, the maximum power point tracking (MPPT) command used is a combination of two efficient and robust controls the PV generator is associated with a neuron network-based control (ANN) to determine the voltage at which the power of the system PV is maximum (Vref).In order to study the solar cell power system of solar unmanned aerial vehicle (UAV), this paperbuilds a simulation model of solar cell according to the solar cell mathematical model. The characteristic curves of the solar cells are compared by changing the solar intensity and the external temperature. To examine the effectiveness of the proposed hybrid control in terms of performance, tracking speed and tracking accuracy, the method is compared with the sliding mode, the system is developed in the Matlab Simulink environment

INTRODUCTION

The photovoltaic system has become one of the most popular renewable and sustainable energy sources. It features the characteristics of sustainability and environmental-friendliness Continuous long flight is the most difficult to achieve the goal of UAV applications but this problem is solved successfully after the application of solar cells to UAV. Sunlight radiant energy is used as energy source for solar unmanned aerial vehicles during thedaytime. The solar array is mounted on the surface of the wings, which can convert solar radiation energy into electrical energy to provide the required energy for propulsionsystems
and airborne equipment, and the excess energy is stored in the battery. The stored energy is used to keep flying at night. When the energy stored in the day is balanced with the energy required for night flight, it can achieve flight for more than 24 hours in theory. Solar energy is one of the most abundant energy, and solar energy is inexhaustible so that it has aroused people's attention. We use MATLAB/Simulink software to build simulation models for analysis and verification before the completion of UAV entities combined with solar cells.

Therefore, it is important to study the output characteristics of solar cell arrays. Solar cells are important part for unmanned aerial vehicle energy system, the output power of solar cell array determines the efficiency of solar unmanned aerial vehicles.
In this paper, the basic principles of solar cells are analyzed and the mathematical simulation model is established by MATLAB/Simulink. Finally, the output characteristics are compared and analyzed by experiments.

The method proposed in this paper represents a hybrid control that combines the neural network (ANN) and integral sliding mode control (ISMC) serial control to track the maximum power this hybrid method brings together artificial intelligence with robustness to give the better performance. In this approach the neuron network will generate the voltage at the maximum power and that is named reference voltage then the integral sliding mode control will decrease the error between the photovoltaic generator voltage and generates the exact duty cycle to the DC-DC converter for maintain the Photovoltaic generator at its maximum power. This method was simulated in the Matlab Simulink using a Boost converter and a resistive load. The performances were tested under fixed and variable atmospheric conditions and the simulation results showed a very good performance.

PV Module :Solar PV Module Solar panel absorbs the the photon energy from the sun and converts it into electricity using the photovoltaic (PV) effect principle. Thin-film or silicon material are used in the manufacturing of of PV modules. This will provide approximately constant power at low cost and also it is pollution free. A general PV cell produces maximum of 3 watts with nearly 1/2V dc. Number of PV cells connected in series or parallel to make a PV module.

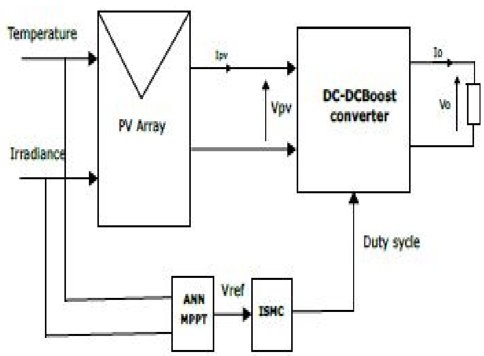


Fig. 1. Proposed system

II. SOLAR CELL CHARACTERISTICS The solar cell is mainly made of PV wafers, converts the light energy of solar irradiation into voltage and current directly for load, and conducts electricity without electrolytic effect. The electric energy is obtained from the PN interface of semiconductor directly; therefore, the solar cell is also known as PV cell .The equivalent circuit of solar cell as shown in Figure1

$$I_{ph} = [I_{scr} + K_i(T - T_r)]\frac{S}{100}$$

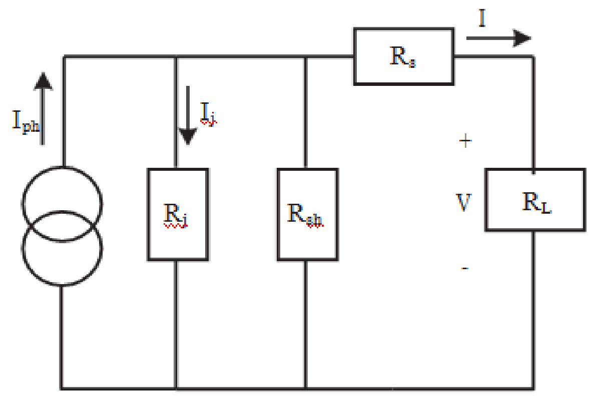


Fig.2 Equivalent circuit of PV array

The current source Iph represents the cell photovoltaic current, Rj is used to represent the nonlinear resistance of the p-n junction, Rsh and Rs are used to represent the intrinsic shunt and series resistance respectively. Normally value of Rsh is very large and Rs is very small. Hence both of them can be neglected to simplify the analysis. PV cells are grouped in larger units to form PV modules. They are further interconnected in series-parallel combination to form PV arrays. The mathematical model used to simplify the PV array is represented by the equation

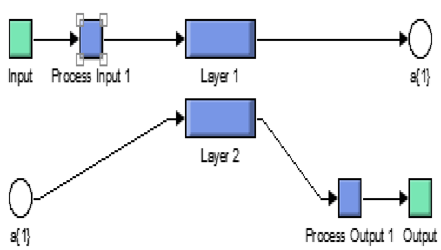
$$I = n_p I_{ph} - n_p I_{rs}\left[e^{\left(\frac{q}{kTA}\cdot\frac{V}{n_s}\right)} - 1\right]$$

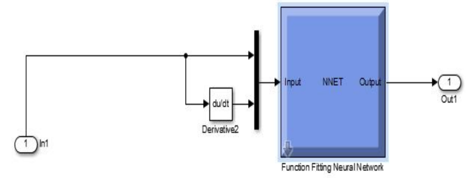
Where I is the PV array output current, V is the PV array output voltage, ns is the number of series cells, np is the number of parallel cells, q is the charge of an electron, k is the Boltzman constant, A is the p-n junction ideality factor, T is the cell temperature, and Irs is the cell reverse saturation current. The factor A decides the deviation of solar cell from the ideal p-n junction characteristics. Its value ranges from one to five. The photo current Iph depends on the solar irradiance and cell temperature as below

Where Iscr is the cell short circuit current at reference temperature and radiation, Ki is the short circuit current temperature coefficient and S is the solar irradiance in mW/cm2. The Simulink model of PV array is shown in Fig. 4. The model includes three subsystems. One subsystem to model PV module and two more subsystems to model Iph and Irs

Artificial neural network (ANN)

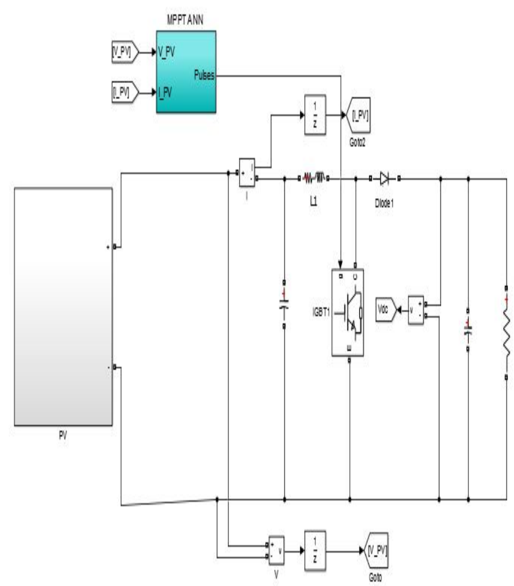
A feed-forward network is adopted here as this architecture is reported to be suitable for problems based on pattern identification. A network first needs to be trained before interpreting new information. Several different algorithms are available for training of neural networks, but the back-propagation algorithm is the most versatile and robust technique for it provides the most efficient learning procedure for multilayer neural networks. Also, the fact that back-propagation algorithms are especially capable to solve problems of prediction makes them highly popular During training of the network, data are processed through the network until they reach the output layer (forward pass). In this layer, the output is compared to the measured values (the \true" output). The difference or error between the two is processed back through the network (backward pass) updating the individual weights of the connections and the biases of the individual neurons. The input and output data are mostly represented as vectors called training pairs. The process as mentioned above is repeated for all the training pairs in the data set, until the network error has converged to a threshold minimum defined by a corresponding cost function, usually the root mean squared error (RMSE).





IV. SIMULATION RESULT

The PV system studied is simulated in the Matlab / Simulink environment. Simulations are performed with variable meteorological conditions: irradiation and temperature The performances are evaluated in terms of precision, time of response and efficiency. Photovoltaic panel parameters: N = 60 ;Iscr = 8:59A; Irr = 5:45A ; Ki = 5:15 ———————————— 10 □ 3A=K ; Tr = 298:15K. BOOST converter parameters: CPV = 4700F; L = 0:53mh; Co = 470F resistive charge: R = 55vv



Simulink diagram for proposed system

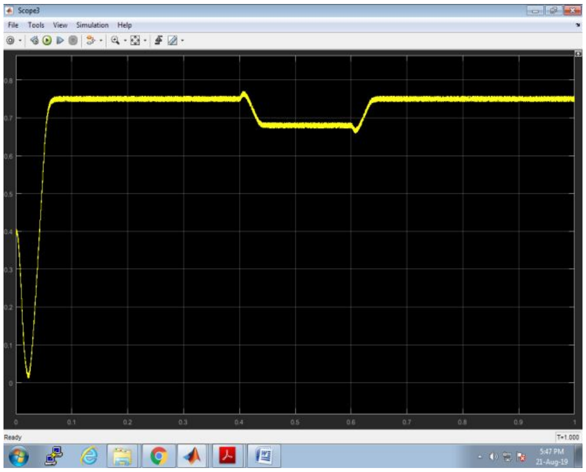
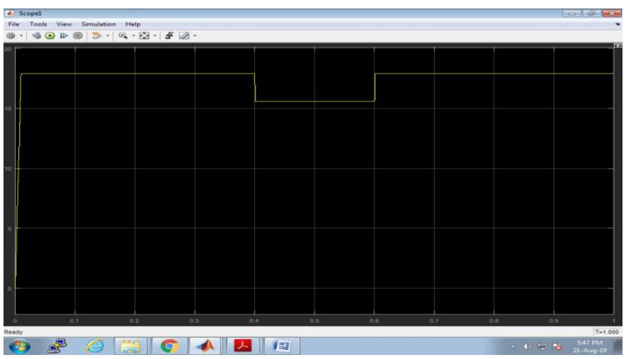
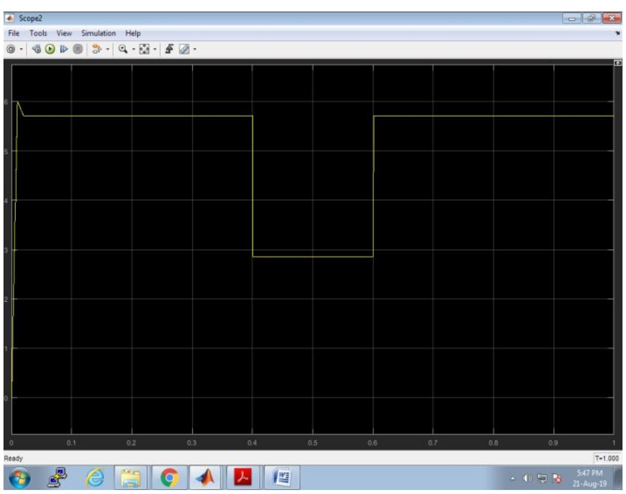


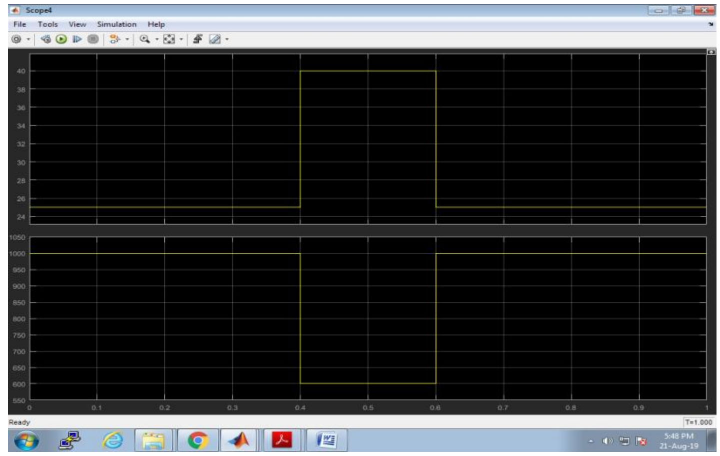
Fig. 10. (a) duty cycle,



(b) PV power,



c) PV voltage



(d) PV current

V. CONCLUSION

In this study, an MPPT technique is designed to control the photovoltaic system. This command takes into consideration the random change of the atmospheric conditions. The system studied included a 240 W photovoltaic panel (KD240GXLPB), a DC-DC boost converter, and a resistive load. The integral sliding mode control (ISMC) takes the reference voltage generated by the neuron network (ANN) and applies to convert DC, DC its duty cycle in order to follow the maximum power. The results of the simulation clearly showed the performance of this approach (speed of response, robustness and accuracy) to track the MPP under variant and non-uniform weather conditions.

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