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Maximum Power Point Tracking of Solar Power Generation Systems Using FCM Clustering

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Abstract: Maximum Power Point Tracking (MPPT) control for stand-alone solar power generation systems via the FCM Clustering model-based approach is considered. A DC/DC boost converter is used to regulate the output power of the photovoltaic panel array. Genetic algorithm optimization technique is employed for solar power generation systems. Furthermore, experimental results show that the system can track the maximum power point accurately and fastly, such that the proposed method can eliminate the power oscillation at maximum power point.

1. Introduction

Maximum power point tracker (MPPT) [1]is a significant segment of solar powered cells power age framework. Solar based cells yield light intensity which changes as the heat changes even in deciding load conditions, yet there exists a most extreme power point, just as a voltage and current relating with the greatest power point. At the point when the workplace changes, particularly the light intensity or surrounding temperature changes, the solar oriented cells yield trademark bend which will change with it, and the Maximum power point likewise will change correspondingly. As a rule, the progressions of solar based cells yield trademark bend corresponding to the progressions of light intensity.

The Boost converter [3] has the value of basic structure, it is likewise a fundamental type of multi-input converter geography for reconciliation of new vitality sources. So Boost converter is utilized to accomplish maximum power following of solar oriented cells in this paper. A PID current mode control fit by Genetic Algorithm[5] is proposed and its performance and application to the guideline of the power converters and PFC are examined.

2. Experimental Methods

The solar oriented power age framework considered here comprises of a PV exhibit and a DC/DC boost converter without loss of all-inclusive statement. It can be observed that the maximum power point is maximized by the PV voltage and is dependent on various insolation and temperature. Most of the photovoltaic clusters yield low voltage, while a large portion of the loads require working at a higher voltage level. Subsequently, the Boost circuit, which has the merits of continuous input current and advancing input voltage is increasingly appropriate to follow maximum power point of photovoltaic framework.

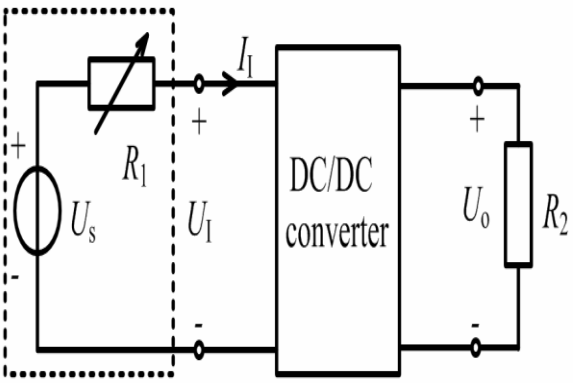


Figure1. The diagram of solar cells simulator

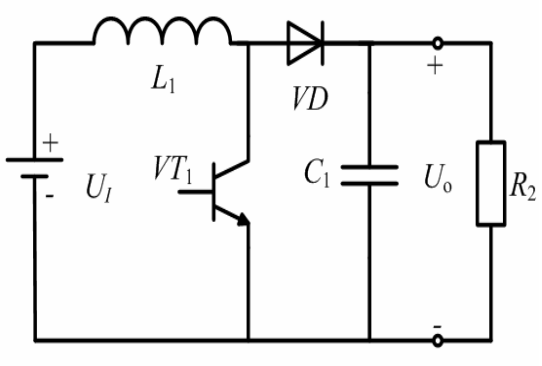


Figure2. Topology of Boost Converter.

In the photovoltaic system, boost converter's input voltage is photovoltaic array's output voltage. The voltage across the inductor can be adjusted by regulating duty ratio *d* so as to achieve the instant at which maximum power, thus the photovoltaic array can finally outputs maximum power.

The facts from the PV exhibit and DC/DC Boost converter by shifting temperature, insolation and duty ratio proportion utilizing MATLAB Simulink is given to the Fuzzy C Means[7] bunching. The FCM bunching is accomplished for three and five groups and the comparing yield has been acquired for various temperature and insolation.

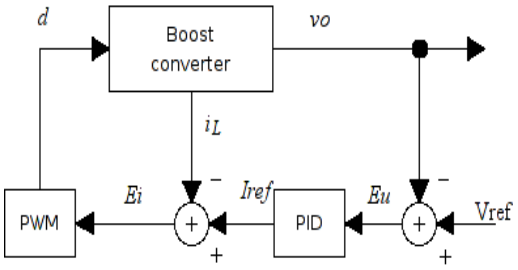


Figure3. Control system configuration

The parameters tuning of PID controller is the combination and optimization of multi-variables; Simple genetic algorithm could solve the shortcoming of current methods of parameters tuning, which can satisfy single requirement of system. It only involves some selection, crossover and mutation operations, but it is so efficient that it can find a nearly optimum solution even for a large scale problem. In this case, a random population of 20 real numbers double precision chromosomes is created representing the solution space for the PID controller (K_P, K_I and K_D codified like the genes of the chromosomes, in the range 0 to 1). Each member of this random population represents a different possible solution for Genetic Algorithm.

The Genetic Algorithm [6] proceeds to find the optimal solution through several generations, the reproduction use crossover fraction of 0, 6 with 2 elite count, the mutation function is adaptive feasible, and the crossover function is scattered. The objective function to minimize was constructed using parameters of the response to step of the system, considering the magnitudes of the variables.

3. Experimental Results and Discussions:

To verify the theoretical derivations, Siemens solar PV module SP75 was used. The boost converter is composed of IRFP450 a power MOSFET, 0.6 mH storage inductance, 1000 μF capacitance *Ca* and *Cb* , and a power rectifier diode. The internal resistances *Rb* and *RL* of capacitance *Cb* and inductance *L* are 162 mΩ and 1 Ω, respectively. The forward voltage of the force rectifier diode is *VD* = 0.57 V. The operational frequency of the converter is set to 100000 Hz.

The temperature of the PV array is varied between 298K to 333K, insolation is varied between 75mW/cm^2 to 85 mW/cm^2 and duty ratio between 0.5 to 0.65. The data have been collected for the above parameter variations and the corresponding output voltages were obtained. The simulated result of PV array and DC/DC Boost converter for a temperature of 298K, insolation of 75mW/cm^2 at 0.5 duty ratio is obtained as shown:

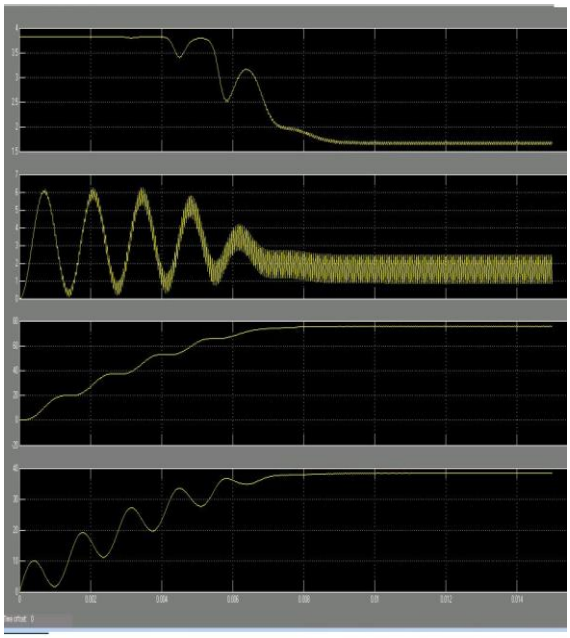


Figure4. i) Io Vs Time, ii) I_L Vs Time, iii)Vo Vs Time, iv) V_{pv} Vs Time

Graph I shows the variation of output current of the DC/DC Boost converter, graph II shows the variation of inductor current, graph III showing the variation of Boosted voltage, and the final graph showing PV array voltage with respect to time.

A set of data have been obtained by varying the parameters as mentioned above and given for FCM Cluster in M-file coding and the results were obtained for varying temperature and insolation for three and five clusters.

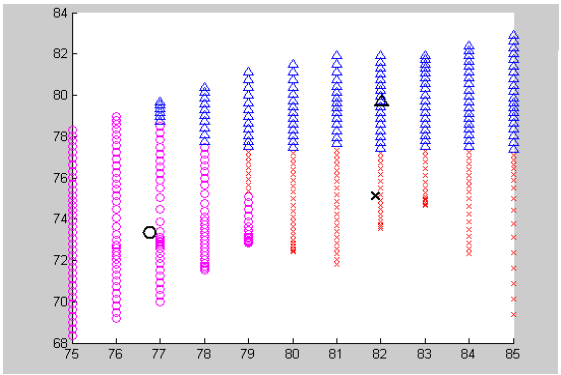


Figure 5. Three clustered output between insolation and output voltage.

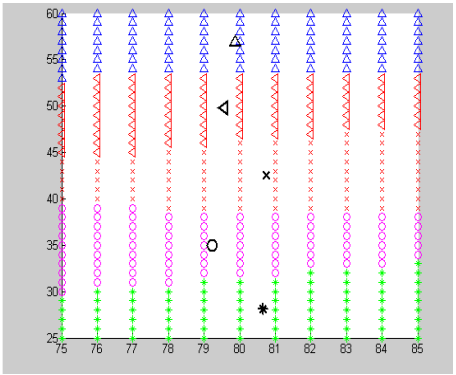
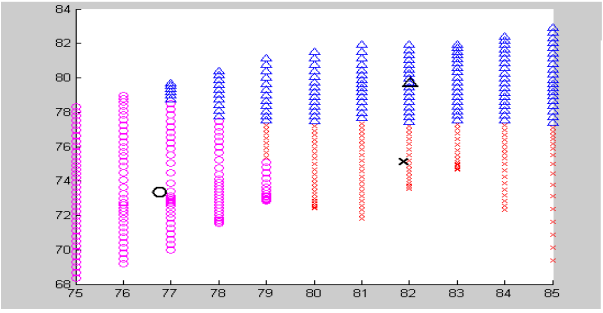


Figure 6.Five clustered output between insolation and output voltage.



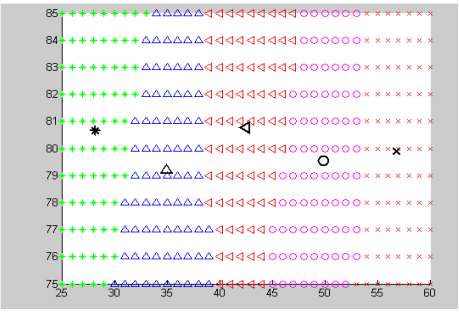


Figure 7.Three clustered output showing the variation between temperature and output voltage.
Figure8.Five clustered output showing the variation between temperature and output voltage.

Thus from the modeling of FCM cluster, it is verified that the optimum output voltage of the Boost converter through MATLAB Simulink is nearly same as that obtained through FCM Cluster which is 80V.

4. Conclusion

FCM Cluster method is proposed for modeling and genetic algorithm for solar power generation systems. The exact MPPT is achieved for varying atmosphere and partial state feedback. Genetic algorithm is used as an alternative of optimal adjustment of the parameters of PID, considering the problem of combination and optimization of multi-variables. The performance of the Boost converter is further improved by using genetic algorithm.

5. References

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