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Increasing Energy Yields with a Novel Adaptive Topology for Photovoltaic Arrays under Partial Shadings

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Abstract.

In order to decrease mismatch loss and boost energy output under partial shadowing (PS), this research suggested a new adaptive reconfiguration method for total-cross-tied (TCT) PV arrays using MATLAB-SIMULINK. In order to maintain equal currents in each row based on shading conditions, the electrical connections between PV modules are changed during this work with the aid of a proposed pattern search algorithm, boosting the current of the array. The suggested algorithm divides the potential number of connections between PV arrays for adaptive systems into categories and selects the best connection between them,tested under various shading scenarios. As opposed to current reconfiguration techniques, this proposed method compares the global maximum power point (GMPP),

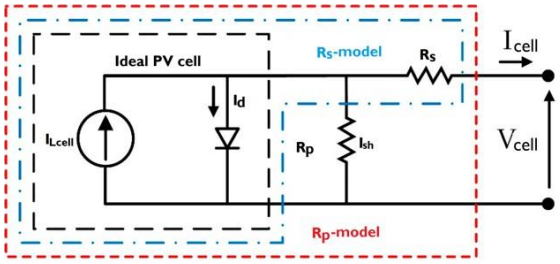
INTRODUCTION

Renewable Energy Source (RES) integration significantlyalters the period of conventional power systems by improving power generation efficiency and fulfilling global demand [1]. Photovoltaic (PV) energy installs quickly amongthe RES and produces enough energy in a short time [2]. In addition, the cost of PV material is reduced on a daily basis compared to other renewables [3].

PHOTOVOLTAIC (PV) MODELING

A PV model is essentially a semiconductor material whose p-n junction is exposed to the sunlight. Photovoltaic cells consist of [4]

several kinds of semiconductors



Single diode PV cell model.

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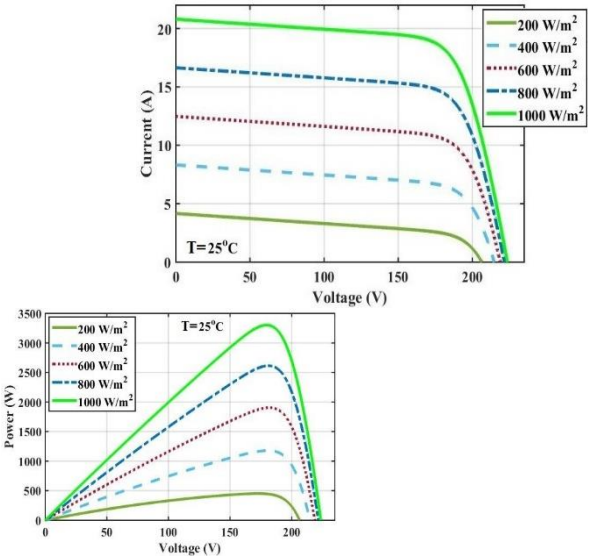
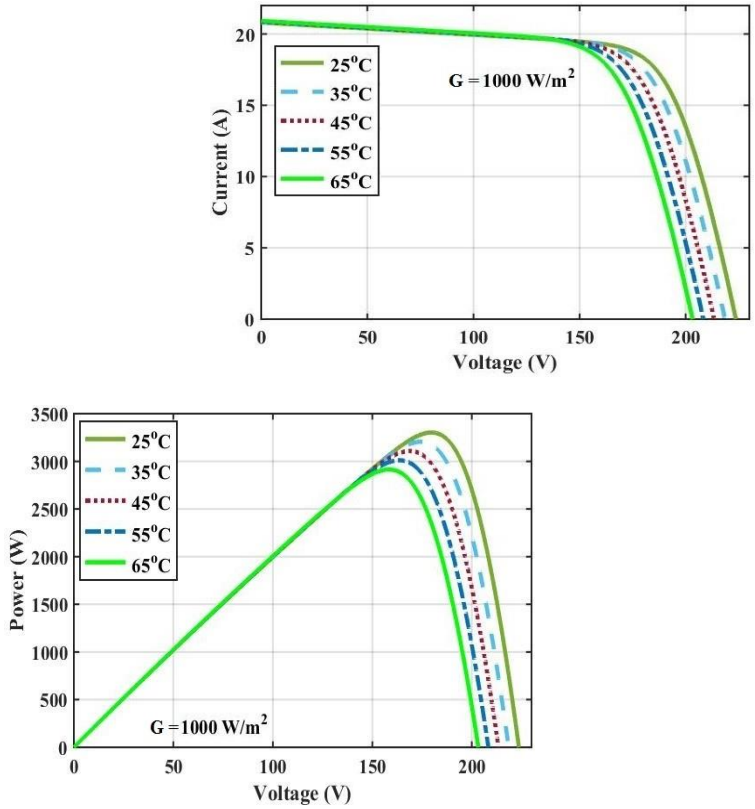


a) I-V curve, (b) P-V curve of 5×4 PV array at
b) various Irradiance levels.

TCT PV array Modelling

TCT connection is a combination of parallel-connected PV modulesas a row and series-connected rows referred toas a string[5]



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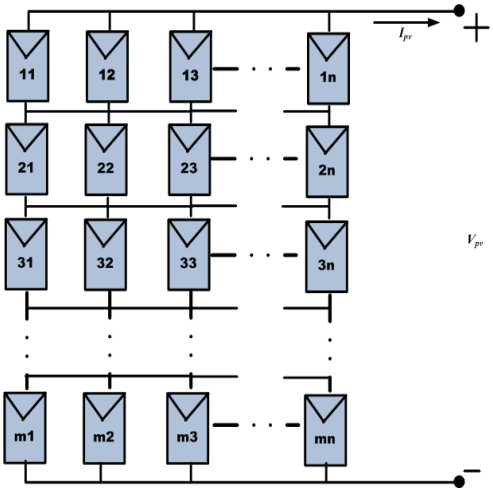
(a) I-V curve, (b) P-V curve of 5×4 PV array atvarious temperature levels.

PROPOSED ADAPTIVE SYSTEM

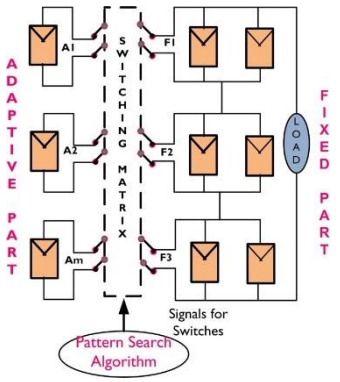
The formation of the proposed system is explained in [6].



TCT PV array Interconnection.

The principal of the proposed method is the forming of

array rows using the modules whose insolation levels are similar[7] to each other Adaptive Reconfiguration



Structure

PATTERN SEARCH ALGORITHM

A pattern search algorithm is proposed in this paper to construct the rows of PV modules whose solar insolation levels [8]in the TCT array are far closer with the help of electrical switching.

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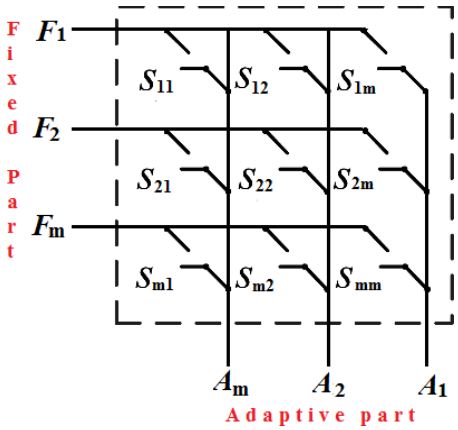
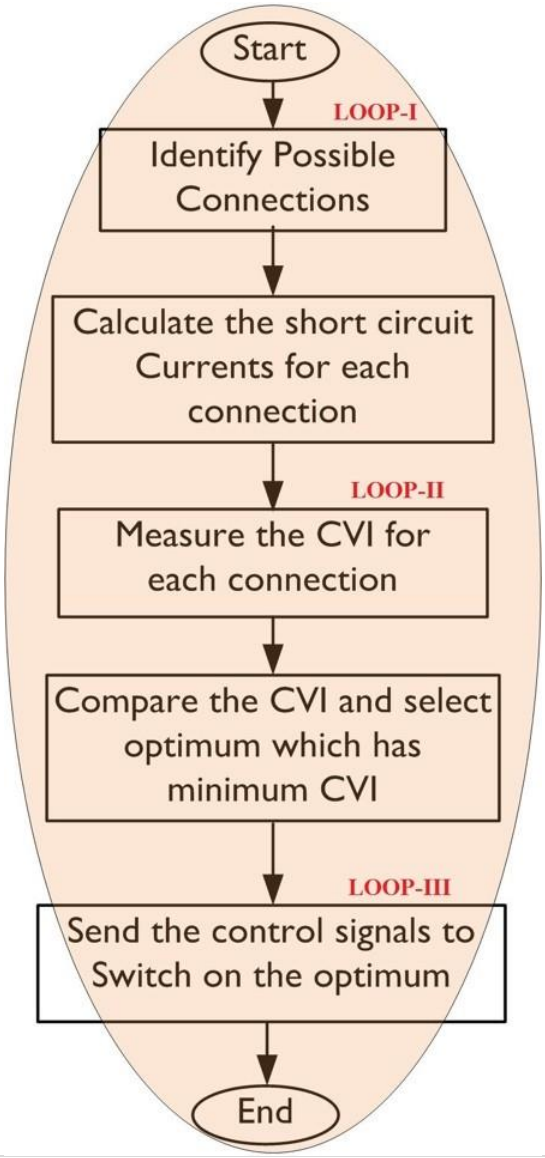


Switching Matirx for reconfiguration

Flowchart of the proposed algorithm



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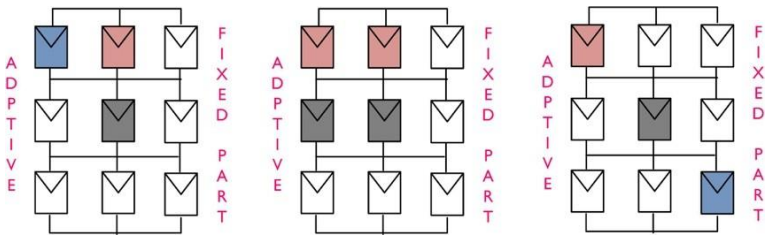
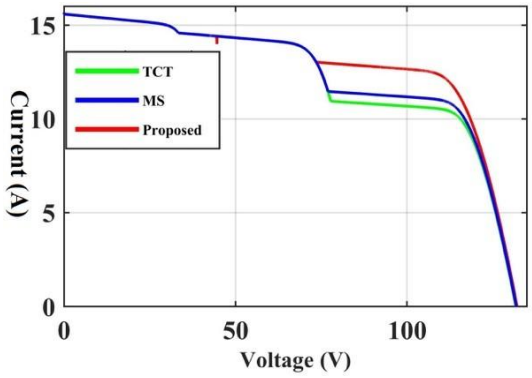
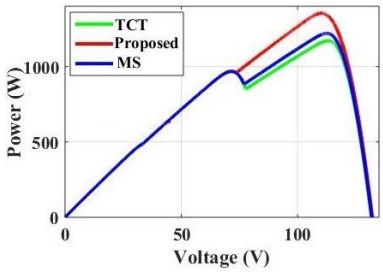
RESULTS AND DISCUSSIONS



Shadings: (a) Row shading, (b) Column shading, and

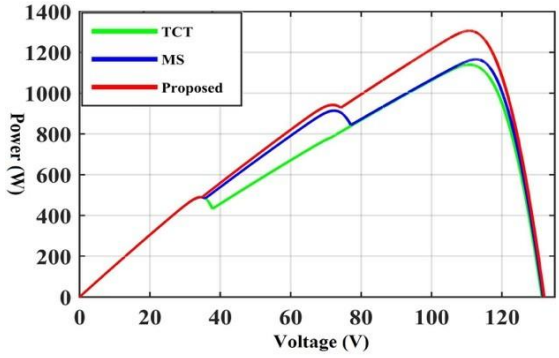


(a) I-V characteristics



Performance characteristics for Row-wise shading.

Performance of Column Shading



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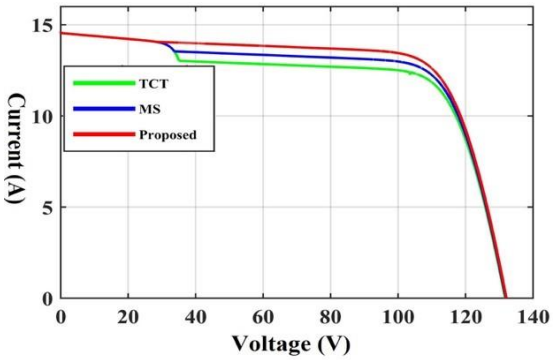
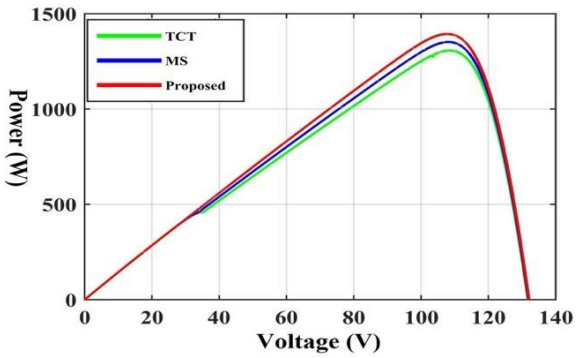
(a) I-V characteristics

(b) P-V characteristics

Performance of Diagonal Shading

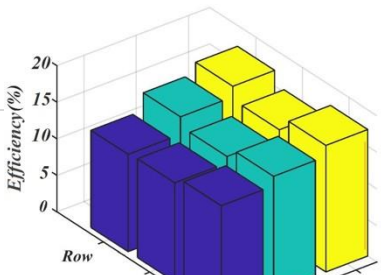


(a) I-V characteristics



(b) P-V characteristics

COMPREHENSIVE STUDY ON CURRENT RECONFIGURATION METHODS



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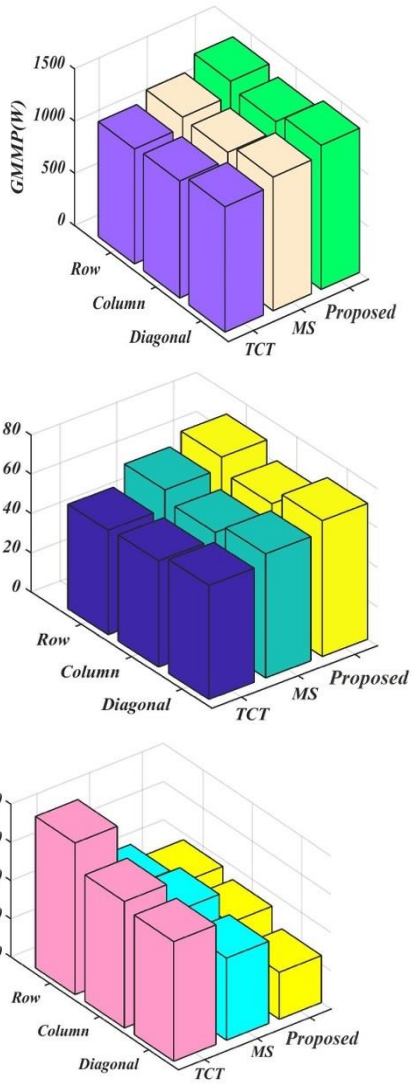

CONCLUSION

In order to increase power production when partial shading and mismatch loss are present, this article proposed an adaptive reconfiguration system.

The 3x3 TCT array is used to implement this method, and standard shading conditions like ro w, column, and diagonal are used to validate it.Additionally, using the global power output, s hadow loss, and fillfactor values that were collected, this adaptive technique is numerically c ompared with the magicsquare method., the suggested adaptive method improved the average fillfactor and power output by 7.2% and 9.6%, respectively, under partial shadings.

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