FPA Based Active Power Control for Voltage-Controlled Through Photovoltaic Inverter for Micro-Grid

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ABSTRACT
A developing concern is the active power control of rising renewable energy sources. For instance, the use of solar energy depends significantly on the central controller and other resources. Some solutions to this issue have been developed in the past, but their performance in terms of power allocation, communication reliance, mode switch, and algorithm complexity is often subpar. In order to change the output power of the two-stage photovoltaic inverter and meet the load demand, this project suggests a simple but effective way using voltage control. In addition, reference power tracking rather than the conventional maximum power point tracking is employed. The power shortage problem is addressed by the mode detection and switch techniques, which enable the PV inverter to maintain the voltage control method even when there is a power shortage. If the maximum power of the solar arrays is greater than the load requirements, the suggested approach can regulate the photovoltaic inverter to organise an islanded micro-grid even without sufficient assistance from other facilities. As a result, solar energy may contribute even more to grid support and make the micro-grid more reliable, sturdy, and cost-effective. The project will use the suggested MPPT control system, which is a very effective FPA-based control system. The key characteristics of the FPA, such as its simpler compilation process and ability to conduct single-stage local and global searches, ensure that the targeted harmonics are eliminated through calculation of the optimum angles. Utilizing MATLAB and Simulink, the output may be implemented.

***Keywords*: Flower Pollination Algorithm (FPA), Maximum Power Point Tracking (MPPT)**

1. INTRODUCTION

Around the world the use of renewable energy use is on the rise and this alternative energy potentially are the key for tacking climate changes. Renewable energy is the form of energy that are produced from the sources that are naturally available to human beings and provided the nature. Most common sources are solar, hydro, wind, geothermal and many more yet to be discovered. Over 80% of the total energy consumed by the human beings is produced from the fossil fuels, however renewable is the fastest growing source of energy in the world. The

advantages of using renewable energy are immense. First and most
Important is that it can combat climate change as it does not emit any greenhouse gases. The only disturbance it causes to the environment are indirect which includes in manufacturing, installation and repairing of these technologies but even these are minimal. Once produced the running cost is minimal as the fuel of operation is free. Solar energy has provided a solution for these problems. A photovoltaic system consists solar modules that are mounted on a structure. These PV system uses irradiation from the sun to produce the direct current. As the solar irradiation is not constant the DC current produced by the solar photovoltaic system varies with solar irradiance which is given by power versus solar irradiance level graph. Now, to work the solar PV system on its maximum power point we need a MPPT controller which would force the solar PV system to work on its maximum power point. A solar photovoltaic system can be operated without a photovoltaic system but then it will result in misapplication of the solar photovoltaic system and hence an MPPT is required. Almost all of the present time MPPT controllers have an excellent efficiency ranging from 94% to 98%. Other method to produce a constant DC bus voltage is to connect is to a grid with the help of an inverter. The dependence of the grid frequency on the active power is of the paramount importance and it needs to be regulated to maintain the frequency of the grid. Apart of this factor if a load is connected to the grid the active power can be supplied to the load with the aid of solar PV thus decreasing the operational cost of the power system and providing a clean energy.

2. EXISTING SYSTEM

The existing project strategies of active power control of the PV inverter can be classified into three types:

3. CONSTANT POWER POINT TRACKING (CPPT)

The PV inverter is managed to follow a specified The operating point of the strategy is determined by the power and energy management stage, and the key objective is to implement reference power point tracking.

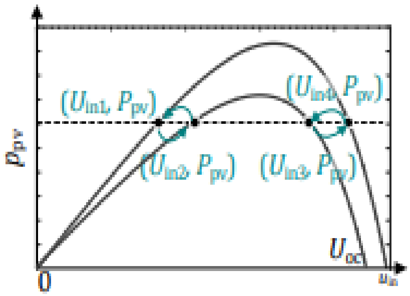

Fig 1: Diagram of CPPT method.

4. MAXIMUM POWER POINT TRACKING (MPPT)

Charge controllers for wind turbines and PV solar systems employ the maximum power point tracking (MPPT) technology to increase power output. PV solar systems can be set up in a variety of ways. In its simplest form, power from collector panels is sent directly to the DC-AC inverter and then to the power grid. A hybrid inverter, a different design, may divide the power at the inverter so that a portion is sent to the grid and the remaining portion is sent to a battery bank. The third variation uses a specialised PV inverter with the MPPT but is not at all connected to the grid. In this setup, a battery bank receives electricity directly. An alternative to these systems is the deployment of micro inverters, one for each PV panel, as opposed to just a single large inverter. According to reports, this can raise PV solar efficiency by up to 20%. There are modern specialist inverters with MPPT capabilities that perform three tasks: splitting off electricity for battery charging, connecting wind and PV solar power to the grid.
The I-V curve can be used to evaluate the complex relationship between temperature and total resistance in solar cells, which results in a non-linear output efficiency. The MPPT system's goal is to sample the PV cells' output and apply the right load (resistance) to get the most power possible under any given environmental circumstances.

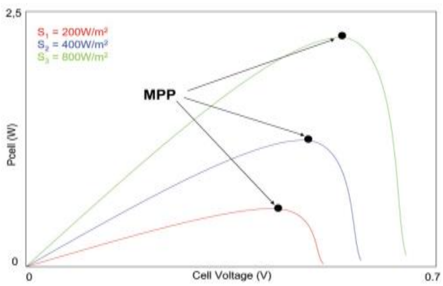

Fig 2: Typical P-V curves for a solar panel

5. EXTENDED MAXIMUM POWER POINT TRACKING (EMPPT)

When things are normal, the PV inverter continues to operate in MPPT mode; but, in an emergency, it will switch to a different operating point. In this case, the steady-state MPP operation is used, and the PV converter only takes part in active power regulation during an emergency. Therefore, it still frequently needs assistance from other facilities.

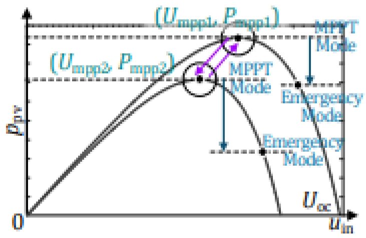

Fig 3: Diagram of EMPPT method.

6. MAXIMUM POWERING POINT QUITTING (MPPQ)

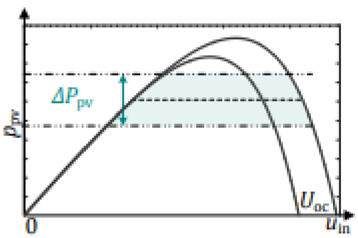

Fig 4: Diagram of MPPQ method

The PV operating point fluctuates with frequency and dc-link voltage and is close to a predetermined value. There are two distinct categories in this approach. One way is to provide a power reference for tracking using a state, like frequency. The deduction of this reference, however, is not thoroughly investigated. In contrast, the PV inverter normally works at a predetermined deload point and modifies its output as other states change. Both techniques offer a power reserve at the expense of a lower output power. Moreover, while dealing with power fluctuations, power management is still crucial.

7. PROPOSED SYSTEM

The active power control of PV stations is becoming more popular as a result of the proposed technologies. Recently, the synchronous generator model has been used in inverters to regulate droop or virtual synchronous generators. These techniques assist with both power allocation and conversion. However, they are unable to function without other power sources, such as batteries or fossil fuels. As a result, the MPPT algorithm may not always be appropriate and it is recommended that the operating modes below MPP be further utilised. To adjust the supplying power to the load requirement, the PV inverter must be used. In a dc microgrid, the islanded mode is employed for voltage regulation. The single-state PV inverter can run in voltage control mode with a straightforward voltage loop for ac applications. The PV curve must meet rigid criteria when using this method. The frequency coupling in dc/dc converter and inverter control, complexity of many control loops, and difficulty in reaching MPP voltage are its limitations. The voltage control approach for the two-stage PhotoVoltic inverter is proposed in.

8. PROPOSED BLOCK DIAGRAM

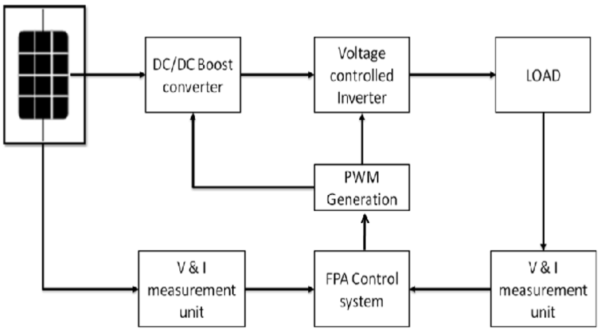

Fig 5: Proposed block diagram

In this research, a brand-new control method for two-stage PV inverters is proposed. After being modified to meet the PV inverter's properties, the power conversion theory from the synchronous generator is used. The inverter must generate, distribute, and regulate voltage and frequency in order for the voltage control method to be effective. The developed theory in FPA control is thus still relevant when using the suggested solution for PV inverters without storage. It should be highlighted that the suggested approach tries to decrease the reliance on communications, power management, and storage. An extreme case where an island micro grid uses exclusively PV inverters as the source is discussed. The suggested approach can a lso be used in other scenarios, such as ones that involve storage, in which case the PV inverter can assist in supporting the grid.

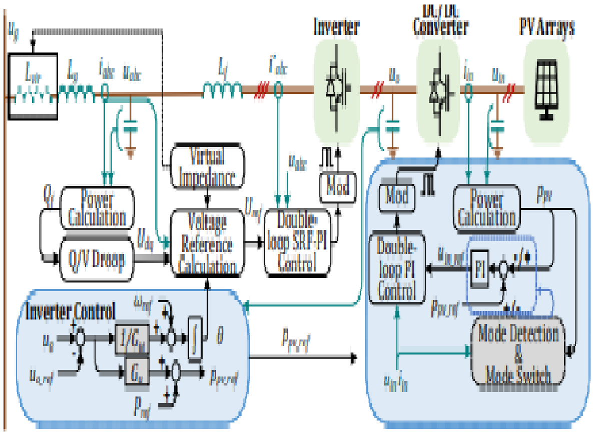

Fig 6: Control Method for two-stage PV inverters

9. INVERTER CONTROL

The two-stage PV inverter in an ac microgrid is given a simple but effective control technique that adjusts PV output power in real time to match load demand and sustain the voltage and frequency of the ac bus.

(a) The proposed voltage control method enhances the conventional current control method of the PV inverter, enabling it to function steadily even in the absence of sufficient storage.

(b) The FPA control of capacitor voltage and output frequency automatically achieves the balance of active power. The inverter power control does not require the active power calculation.

(c) The proposed approach mimics the synchronous generator's power conversion mechanism. Reactive power regulation and secondary restoration, two developed technologies used in the traditional voltage management technique, are therefore applicable to this strategy as well.

10. MPPT Control

For power control of PV arrays, power point tracking is utilised instead of MPPT. The power shortage problem is addressed by the mode detection and switch techniques, which enable the PV inverter to maintain the voltage control method even when there is a power shortage.

11. FLOWER POLLINATION ALGORITHM (FPA)

The flower pollination algorithm (FPA), a meta-heuristic optimization technique based on replicating the pollination process of flowers, was proposed. Self-pollination and cross-pollination are the two types of pollination. In self-pollination, the pollen from one flower travels to fertilise another one that is identical, and the fertilisation process is carried out between the flowers of the same types. Cross-pollination is the process by which insects like birds, bees, and bats move pollen over great distances between various plants. A phenomenon known as floral constancy describes how some insects prefer to visit certain flowers over others. Generally speaking, the following guidelines could be used to explain the flower pollination process:

1. Global pollination utilised to scour the search space for the most promising places is what is meant by the terms "biotic" and "cross-pollination." Based on the levy distribution, this phase.

2. The local pollination used to take advantage of the areas close to the current solution in order to speed up convergence is known as "biotic self-pollination."

3. The floral constancy attribute can be thought of as a reproduction ratio proportionate to how similar two flowers are to one another.

4. Due to the close proximity and wind, local pollination has a modest advantage over global pollination. More specifically, a control variable P with a value between 0 and 1 regulates both local and global pollinations.

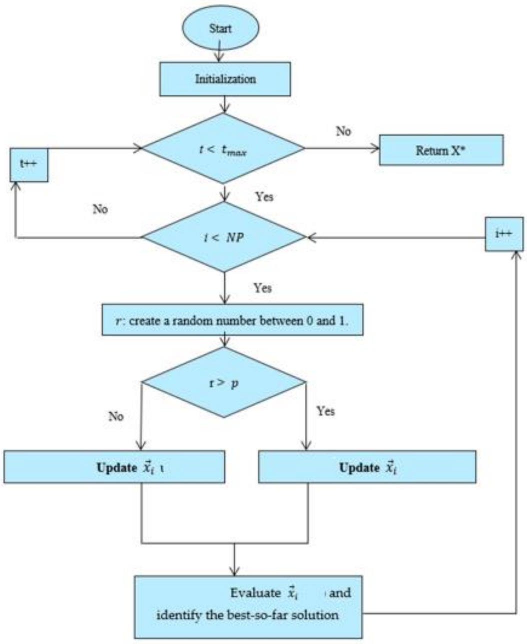

Fig 7: FPA Flow Char

12. RESULT AND DISCUSSION

The below figure 8 is Library Browser for Simulink

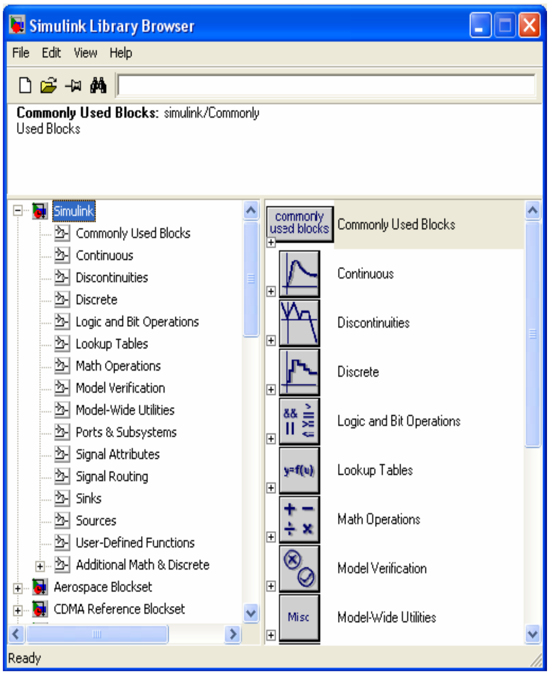

Fig 8: Library Browser for Simulink

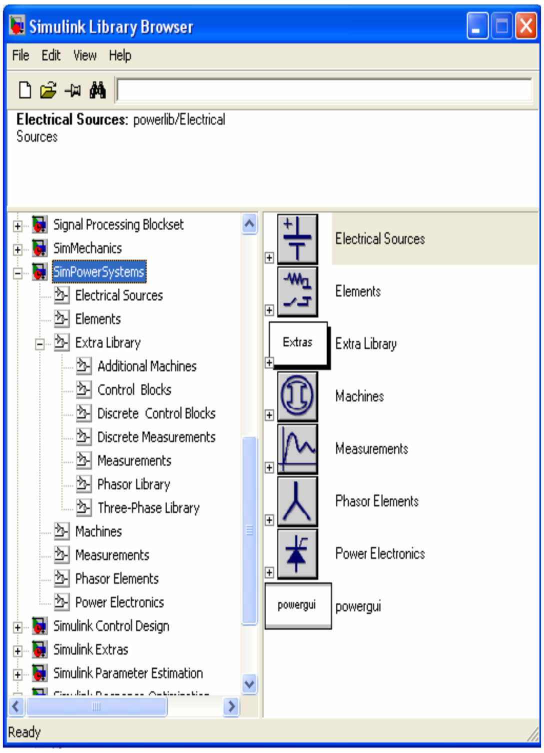

Fig 9: Library Browser for Simulink Power system

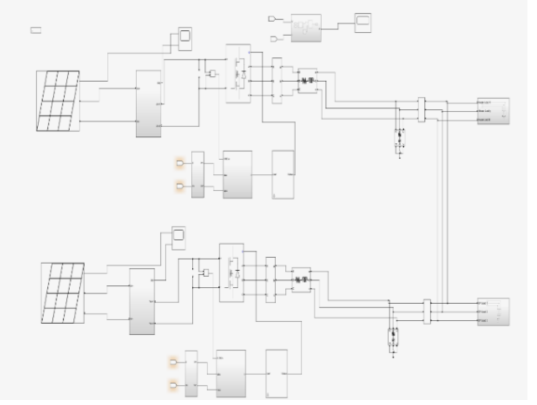

Fig 10: Proposed Simulink model

The above figure 10 is proposed Simulink model FPA based active voltage control inverter.

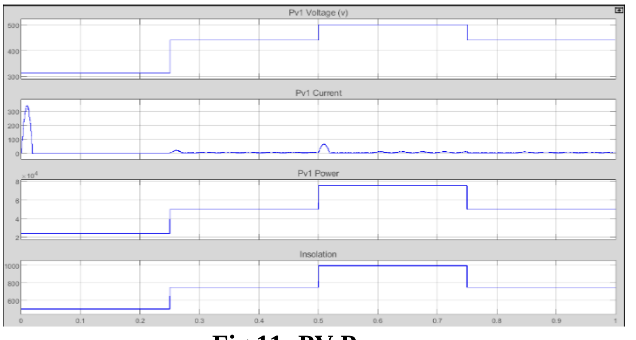

Fig 11: PV Power

The above figure 11 is output waveform for PV voltage, current, power and insulation.

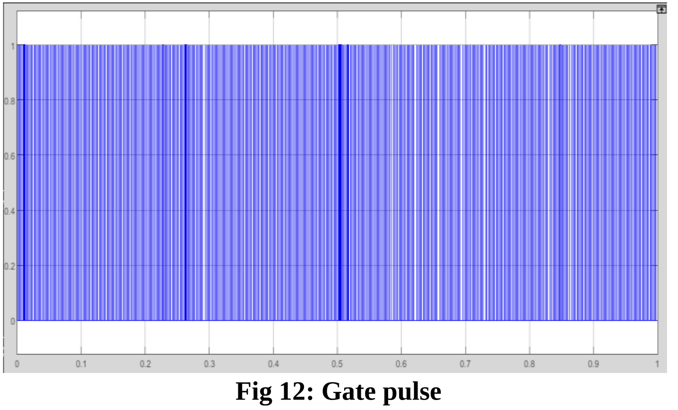

Fig 12: Gate pulse

The figure 12 shows Gate pulse in boost converter switching pulse.

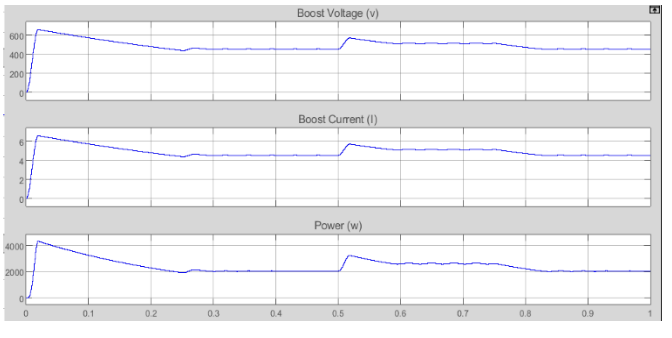

Fig 13: Boost voltage

The figure 13 is shown boost voltage, current and power. The boost voltage: 500 VDC, current: 5Amps, power: 2000watts

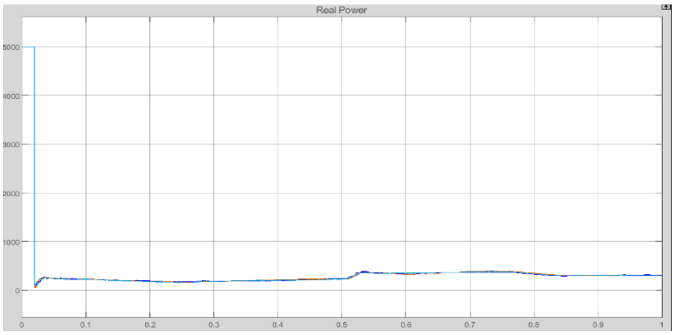

Fig 14: Real Power

The above figure 14 is output of real power control of FPA based control system.

13. Conclusion

The photovoltaic generator is a revolutionary control method that is proposed in this research. The established synchronous generator power conversion theory is examined and contrasted with the PV inverter power conversion principle, from which a simple but efficient format is generated, examined, and proven by simulation and experiment. If the maximum power of the photovoltaic arrays is greater than the power required by the load, this method can manage the inverter steadily and organise an island microgrid. The operations of solar energy should support the grid more. This study investigates an alternative approach for the PV inverter to handle these duties. The findings demonstrate the standalone load-powering ability of the FPA-based PV inverter, which may also be applied in situations involving other energy sources. The proposed approach has the advantage of enhanced grid support through voltage management and islanded operation, at the cost of lower power output. As a result, the suggested solution can contribute to grid support in light of the growing use of solar energy and the resulting need for more flexible PV inverters.

14. References

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