IJNRD.ORG ISSN : 2456-4184
INTERNATIONAL JOURNAL OF NOVEL RESEARCH AND DEVELOPMENT (IJNRD) | IJNRD.ORG
An International Open Access, Peer-reviewed, Refereed Journal

Application of Optimal PSO MPPT Controller for Grid Connected PV System

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Abstract:

Despite the global financial difficulties, the renewable energy industry has remained resilient and has managed to hold its own. This shows that the industry is well-equipped to meet the demands of a clean and secure energy economy. The rapid growth of the global economy has created an opportunity for the renewable energy industry to expand at a fast pace. However, to truly meet the world's energy needs, governments need to support the industry in various ways. The world's energy supply is heavily dependent on fossil fuels. By 2030, oil will still be the main fuel used globally, accounting for approximately 80% of the primary energy. In this paper Optimal MPPT Controller is proposed with Particle Swarm Optimization (PSO) Algorithm. The proposed controller is modelled in MATLAB/SIMULINK. The Results shows the Effectiveness of the Controller.

Keywords: PSO, MPPT, PV System

I. Introduction

With a huge energy resource base, India is capable of sourcing fossil fuels and non-conventional sources of energy. Coal is the main source of energy for the country, accounting for over 50% of India's total consumption. The country's dependence on oil imports is expected to increase significantly, as it is a major source of energy. Gas consumption is also expected to increase by 38% in 2016-2020. In 2016, India is expected to import about 200 million tons of coal, which is significantly higher compared to the 90 million tons that it imported in 2015. Despite the abundance of coal, it is still constrained by high ash content and environmental concerns. [1].

Despite the huge potential of India's renewable energy market, its operation is still in its infancy. In many ways, it is still behind the standards of developed nations. Despite the huge potential of India's renewable energy

market, the country's high energy needs are still being met primarily by petroleum and coal. Non-permanent service to the power grid is also harmful to the environment. The rising price of crude oil has affected the country's economy, which means that various power sources need to be developed in order to meet the country's growing needs. This is also expected to mean that the country has to transition from using coal and crude oil to renewable energy. [2]-[4].

This transition will involve the use of various renewable resources such as wind, solar, and tidal power. Aside from these, various power generation systems such as wind turbines and biomass can also be utilized. Coal-based generation contributes to India's total energy generation, which is about 68.6% of its total capacity. This is also due to the presence of captive power plants with a total capacity of 1MW. With the implementation of various policies, India's total power demand is expected to increase to 400,000 MW by 2030. To meet this target, the country needs to add 215,000 MWs of new generation by 2030. [5]-[8]

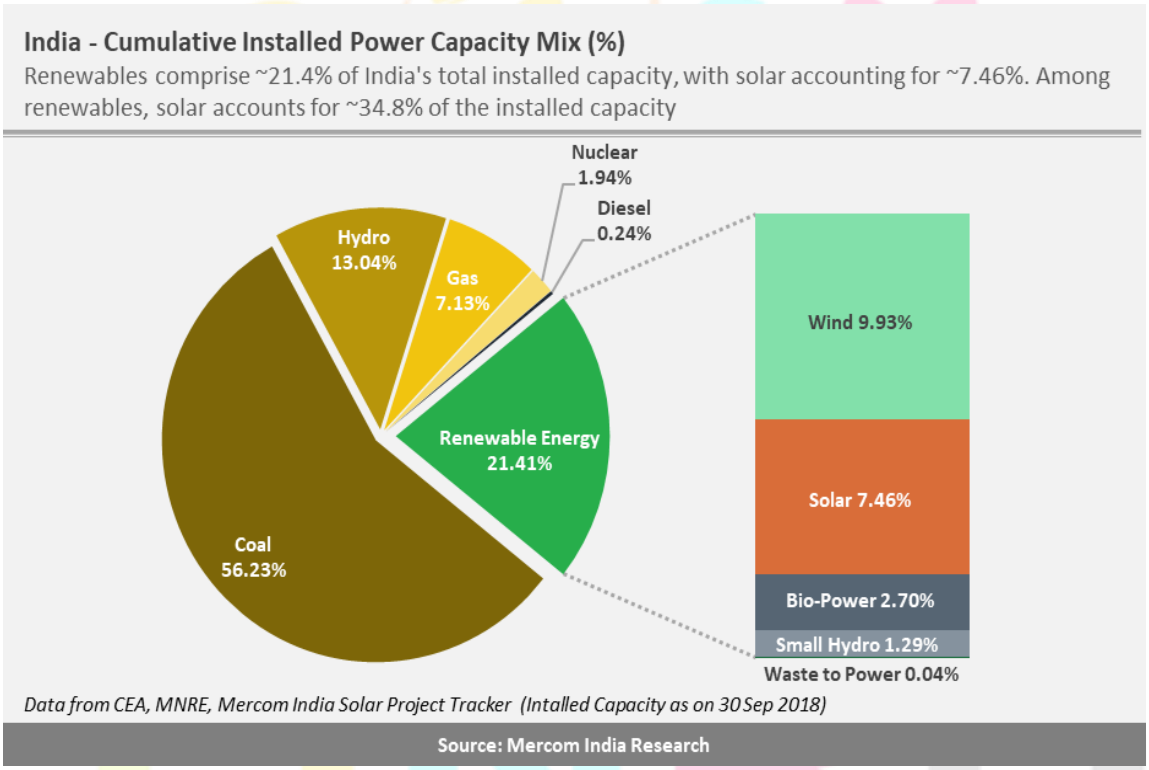

Fig. 1. Installed Power Capacity in India

With a potential to generate up to 60,000 MWs of solar power, India can easily meet its electricity needs. It can also produce 50,000 MWs of hydroelectric power through local waterways. In order to meet its target, India needs to add 50,000 MWs of nuclear power by 2030. This resource can be utilized in conjunction with wind and solar power, which can generate up to 20,000 MWs of electricity. Converting the various waste streams in the country into electrical power can be achieved through the use of mixed cycle technology. This method would involve the use of gasification and the elimination of pollutants from the electricity supply. [9]-[10]

II. Particle Swarm Optimization

Kennedy and Eberhart first introduced particle swarm optimization in 1995. According to sociobiologists, a school of fish or a flock of birds that moves together "may benefit from the experience of all other members," as

stated in the original publication. In other words, while a bird is flying and looking for food haphazardly, for example, all of the birds in the flock can share their discoveries and assist the flock as a whole in having the most successful hunt. In simulating a flock of birds, it's also possible to assume that each bird is helping us find the ideal solution in a high-dimensional problem space, and the flock's best solution is the best solution in the space. The reason why this is a heuristic answer is, we can never verify the actual global optimal solution can be found, and it typically isn't, thus this is a heuristic solution. The PSO solution is frequently, nonetheless, pretty near to the overall ideal.

Particle swarm optimization is a computational technique that involves trying to improve a given candidate solution by moving particles around in a search-space according to a simple math formula. Each particle is guided to its best known position in the search space. As long as other articles are finding better positions, the swarm will move toward the best solutions. This algorithm was refined and it was observed that it was performing well. A comprehensive review on its various applications has been published by Poli and Bonyadi. PSO is a metahuristic approach that can search large spaces of potential solutions. PSO does not use the gradient of the problem being studied, which means it does not require the use of other methods such as descent gradient.

The basic concept of PSO is that a population of particles is organized into groups called swarms. These particles are then moved in the search-space according to the simple formulae provided by the algorithm. After the positions of the swarms are determined, the algorithm will then guide the movements of the particles in the search space. The function takes a given candidate solution and outputs a real number that represents the objective function value of that particular solution. The goal is to find the solution that satisfies the global minimum. The flow chart of PSO algorithms is shown in Fig. 2.

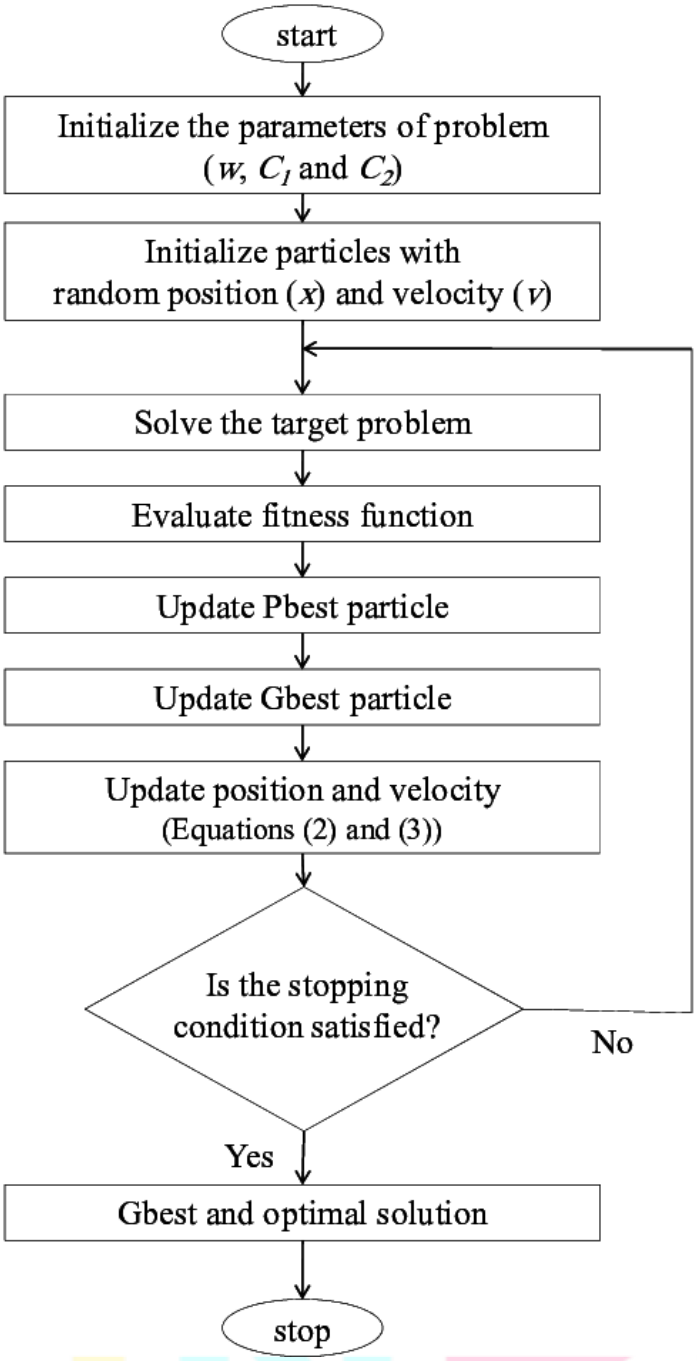

Fig. 2. Flow Chart of PSO Algorithm

III. Results and Discussion

In this paper PSO MPPT Controller is proposed and implemented in MATLAB under following cases.

- Case: 1 Constant solar irradiance and ambient temperature
- Case: 2. Variable/Partial Shaded condition

Case 1: Constant solar irradiance and ambient temperature:

In this case the following are the conditions

- Solar irradiance is 1000 W/m^2.
- Ambient Temperature is 25 ^{0}C.

The results in this case are shown in Fig. 3

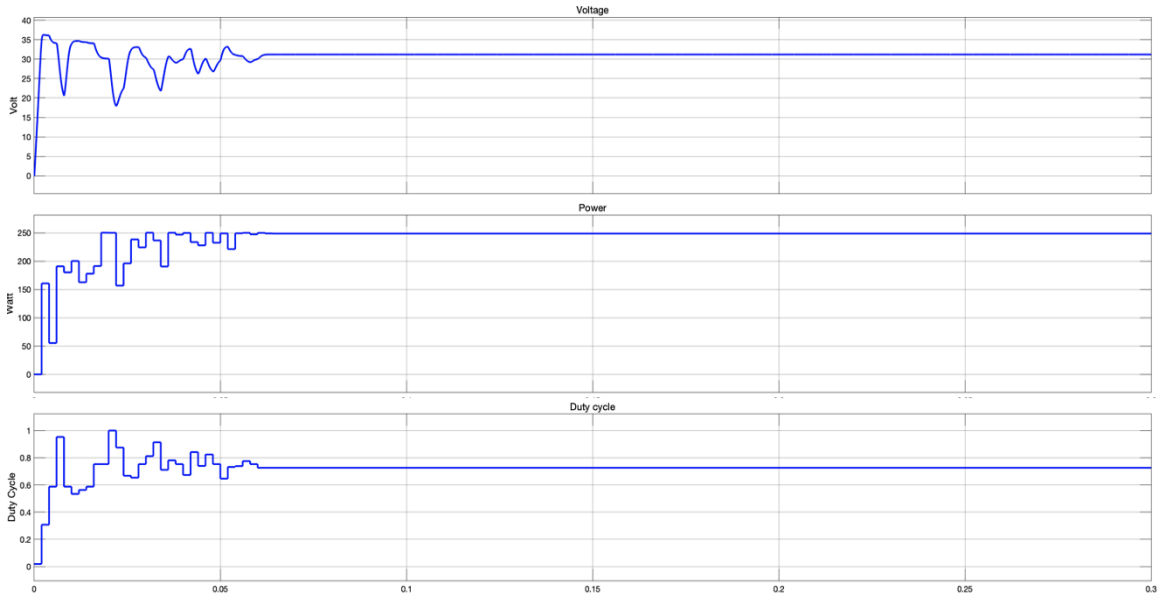

Fig. 3 Performance of Proposed PSO MPPT under Constant Conditions

Case 2: Variable/Partial Shaded condition:

In this case the following are the conditions

- Solar irradiance is 300, 800, 700 W/m^2.
- Ambient Temperature is 25 ^{0}C.

The results in this case are shown in Fig. 4

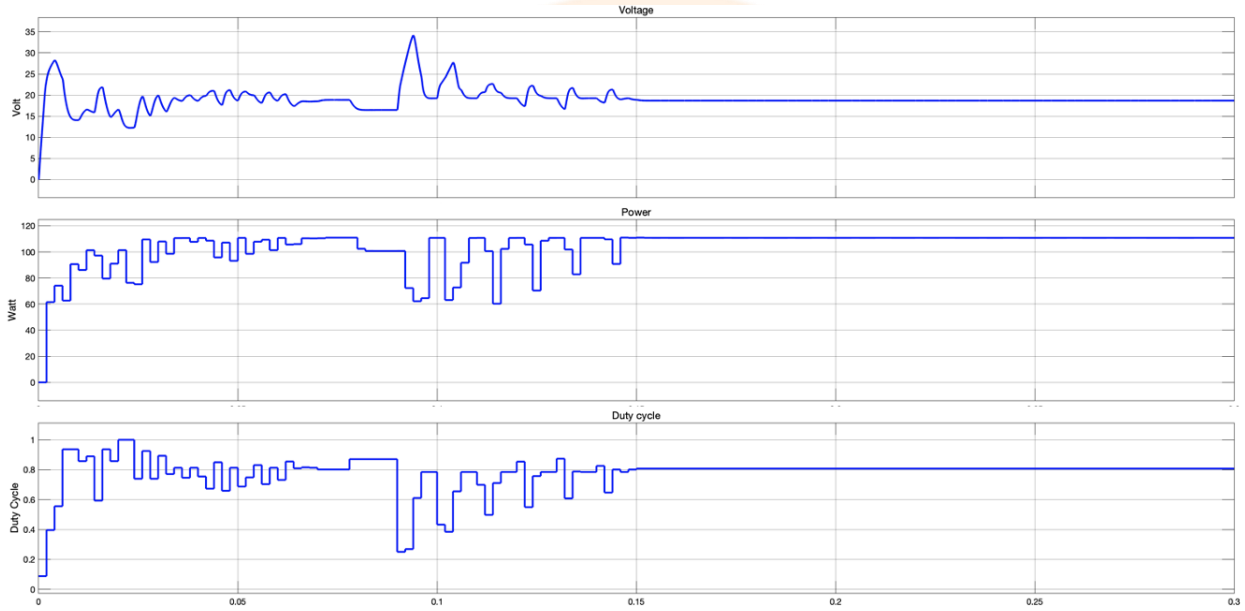

Fig. 4 Performance of Proposed PSO MPPT under Variable/partial Shaded condition

From the above result the proposed PSO MPPT controller shows its Mark Performance.

IV. Conclusion

This paper presents an PSO-based method for monitoring MPP in constant and variable/partial shaded radiance levels. A boost converter topology was also used to improve the searching technique. The proposed algorithm involves taking the linear decreases and increasing the number of step sizes to get the particle search velocity up. This method achieves its goal by avoiding an excessively small step size that can make local optimum traps unavoidable. The simulation results show that the proposed method can detect the maximum power point of a solar system. It can also be utilized for high-quality setups. Finally the results validated the effectiveness of the proposed PSO MPPT controller.

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