COMPARISON OF PSO AND DE ALGORITHM BASED MPPT ALGORITHM FOR SOLAR ENERGY SYSTEM

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ABSTRACT

This paper proposes a comparison between two MPPT algorithms. MPP is achieved in renewable energy systems such as solar energy system. Various algorithms are used to achieve MPP. In this paper the particle swarm optimization and differential evolution algorithm are used to achieve the maximum power from the solar energy system. The particle swarm optimization using the particles best position and velocity in general which is been implemented in the solar energy system for achieving maximum power. The differential evolution algorithm uses the iterative technique to optimize the solution that is to be obtained. These two optimization algorithms are compared in this paper to achieve the solution to get maximum power from the solar energy system.

Keywords: Differential Evolution (DE), Maximim Power Point Tracking(MPPT), Maximim Power Point (MPP), Particle Swarm Optimization(PSO), Voltage Source Converter (VSC)

I. INTRODUCTION

The demand for power is increasing in the modern era. The availability for the generation sources is limited in modern era as the fuel is depleting. The solution to it will be the renewable energy sources. Access to quality, reliable and affordable energy is critical for promoting economic and social development in rural areas. Due to increased standards in people's living and growth population and rapid development in industrialization etc., the energy demand has been increased at a faster rate and hence the gap between generation and demand has considerably increased. Distributed Generation (DG) is the power generation from sources available at the distribution end which are generally renewable energy sources. Usage of DG is increasing since distributed energy systems with renewable sources have achieved great potential in providing reliable and continuous power to the rural areas where grid power in unreliable and not continuous. The increasing demand in the electrical energy and the focus on environmental protection has pushed us to concentrate mainly on developing renewable energy sources which is completely harmless to environment. United Nations is planning 50% of total energy from renewable sources by 2050, Europe 20% by 2020 and India 10% by 2012. Renewable energy source (RES) integrated at distribution level is termed as distributed generation (DG). The utility is concerned about the issues created due to the high penetration level of intermittent RES in distribution systems as it may pose a threat to network in terms of stability, voltage regulation and power-quality (PQ) issues. Therefore for grid integration the DG systems are required to comply with strict technical and regulatory frameworks to

ensure safe, reliable and efficient operation of overall network. With the advancement in power electronics and digital control technology, the DG systems can now be actively controlled to enhance the system operation. However, the extensive use of power electronics based equipment and non-linear loads at PCC generate harmonic currents, which may deteriorate the quality of power. But at the same time achieving maximum possible power from RES is also an issue. In this paper solar energy is used in interconnection with the grid and the MPPT is used to get maximum possible power from solar.

II. ENERGY SOURCES

Natural resources such as oil, coal, or the sun, which can be used to provide power for light, heat, machines, etc. We are committed to the development of clean and renewable energy sources. The world's energy resources can be divided into fossil fuel, nuclear fuel and renewable resources. Based on long-term availability the energy resources are classified as,

- Non-renewable energy resources.
- Renewable energy resources.

2.1Non Renewable Energy

A non-renewable energy source is a source that does not restore itself at significant rate for sustainable economic extraction in meaningful human time-frames. An example is carbon-based, organic fuel. The organic material when subjected to changes with the aid of heat and pressure becomes a fuel such as oil or gas.

2.2 Disadvantages of Non-renewable Energy Resources

- Fossil fuels generate pollution. These pollutants degrade the environment, cause health hazards. Mainly carbon dioxide which causes global warming.
- Coal a petrochemical is used as raw material for chemical, pharmaceutical and paint industries. In long-term it is desirable to conserve coal for future needs.
- The waste materials in nuclear plants has radioactivity quotients of dangerous levels, it remains above the safe limit for long period and is health hazard.
- Possibility of accidental leakage of radioactive material from reactor is another safety issue.
- Non-renewable sources will finish up one day.
- Conventional sources are not sufficient to meet the growing demand.

Due to these reasons it has become necessary to identify non-conventional or renewable resources to reduce too much dependence on conventional or non-renewable resources. India is the only country having a full-fledged ministry devoted especially to developing new and renewable energy sources.

2.3 Advantages of Renewable Energy

- Its acts as a solution to the energy problem for the stabilization of carbon dioxide emissions and other greenhouse gases. Replaces energy generation plants which use conventional sources lead to a reduction in the emission of pollutants such as sulphur and nitrogen oxides which cause acid rain.
- Domestic sources of energy and contribute to increasing energy independence and society of energy supply at the national level.

- Geographically dispersed leading to the decentralization of the energy system making it possible for energy needs to be met at a local and regional level reducing losses from energy transmission.
- They provide opportunities for rational use of energy sources because they cover wide range of energy needs.
- Low operating costs which are not influenced by fluctuations in the international economy and especially in prices for conventional fuels.

16% of global energy consumption presently comes from renewable resources, 10% of energy from traditional biomass used for heating, and 3.4% from hydroelectricity. New renewable account for another 3% and are increasing rapidly. National renewable energy markets are projected to continue to grow strongly in the coming decade and beyond. Renewable energy sources all over wide geographical areas in contrast to other energy sources which are concentrated in a limited number of countries to particular areas. Rapid deployment of renewable energy and energy efficiency is resulting in significant energy security, climate change mitigation, and economic benefits. In international public opinion surveys there is strong support for promoting renewable sources such as solar power and wind power. While many renewable energy projects are large-scale, renewable technologies are also suited to rural and remote areas and developing countries.

III. MAXIMUM POWER POINT TRACKING

Maximum Power Point tracking is a technique that is used to get maximum possible power from one or more photo-voltaic (PV) devices. Solar cells have a complex relationship between solar irradiation, temperature and total resistance that produces non-linear output efficiency which can be analyzed based on I-V curve. It is MPPT system to sample the output of the cells and apply the proper resistance load to obtain maximum power for any given environmental conditions. MPP (Maximum power point) is the product of the MPP voltage (V_{mpp}) and MPP current (I_{mpp}). MPPT devices are typically used in electric power system that provides voltage or current conversion, filtering, and regulation for various loads such as power grids, batteries, or motors. Maximum Power Point Tracking frequently referred to as MPPT is an electronic system. MPPT is an essential part of PV system. It operates in a manner such that it optimizes the power generated by the photovoltaic panel. It functions as an optimal electric load for a PV cell, and converts the power to a voltage or current level which is more suitable to whatever load the system is designed to drive. It consists of a DC-DC converter which limits power loss by matching the photovoltaic panel and the load impedances by varying the duty cycle of the switch used in the converter circuit.

3.1 Mppt Algorithm

MPPT s utilizes some type of control circuit or logic to search for the MPP and thus allow the converter circuit to extract maximum power available from a PV. There are various controlling algorithm which are used as the tracking algorithms.

3.2 Types of Mppt Algorithm

They are mainly grouped as indirect method and direct method of tracking. The indirect methods have a particular feature that the MPP is estimated from the measures of PV Voltage, Current, the irradiance and

temperatures, by mathematical expressions of numerical approximations. Therefore, the estimations is carried out for a specific PV panel and they do not obtain the maximum power for varying irradiance or temperature.

The various indirect method of controlling are,

- Curve- Fitting Method
- Look-up Table Method
- Open-Circuit Voltage PV Generator Method
- Short-Circuit PV Generator Method
- Open-Circuit PV test Cell Method

None of them are able to obtain the MPP exactly due to various disadvantages.

The Direct method offers the advantage that they obtain the actual MPP by sensing the PV voltage and current. They are also suitable for any irradiance and temperature. There a numerous algorithms followed to obtain the MPP such as

- Perturbation and Observation Algorithm (P & 0)
- Feedback Voltage (or Current) method
- Maximum Power Point Voltage
- Parasitic capacitance Method
- Incremental Conductance Algorithm (INC)

IV. PROPOSED CONTROLLER

4.1Particle Swarm Optimization

In general Particle swarm optimization (PSO) is a computational method that optimizes a problem by iteratively trying to improve a candidate solution with regard to a given measure of quality. PSO optimizes a problem by having a population of candidate solutions, here dubbed particles, and moving these particles around in the search-space according to simple mathematical formulae over the particle's position and velocity. Each particle's movement is influenced by its local best known position but, is also guided toward the best known positions in the search-space, which are updated as better positions are found by other particles. This is expected to move the swarm toward the best solutions.

A basic variant of the PSO algorithm works by having a population (called a swarm) of candidate solutions (called particles). These particles are moved around in the search-space according to a few simple formulae. The movements of the particles are guided by their own best known position in the search-space as well as the entire swarm's best known position. When improved positions are being discovered these will then come to guide the movements of the swarm. The process is repeated and by doing so it is hoped, but not guaranteed, that a satisfactory solution will eventually be discovered.

4.2 Differential Evolution

Differential evolution (DE) is a method that optimizes a problem by iteratively trying to improve a candidate solution with regard to a given measure of quality. DE do not guarantee an optimal solution is ever found. DE is used for multidimensional real-valued functions but does not use the gradient of the problem being optimized, which means DE does not require for the optimization problem to be differentiable as is required by classic optimization methods such as gradient descent and quasi-newton methods. DE can therefore also be used on

optimization problems that are not even continuous, are noisy, change over time, etc. DE optimizes a problem by maintaining a population of candidate solutions and creating new candidate solutions by combining existing ones according to its simple formulae, and then keeping whichever candidate solution has the best score or fitness on the optimization problem at hand. In this way the optimization problem is treated as a black box that merely provides a measure of quality given a candidate solution and the gradient is therefore not needed. A basic variant of the DE algorithm works by having a population of candidate solutions (called agents). These agents are moved around in the search-space by using simple mathematical formulae to combine the positions of existing agents from the population. If the new position of an agent is an improvement it is accepted and forms part of the population, otherwise the new position is simply discarded. The process is repeated and by doing so it is hoped, but not guaranteed, that a satisfactory solution will eventually be discovered.

V. SIMULATION AND RESULTS

The simulation of the test system is done by using MATLAB/Simulink environment. The block diagram for the test system is shown in the fig 1.

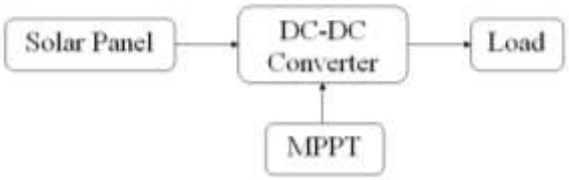

Figure 1. Block Diagram of Test system

The simulation diagram of the test system is shown in fig.2.

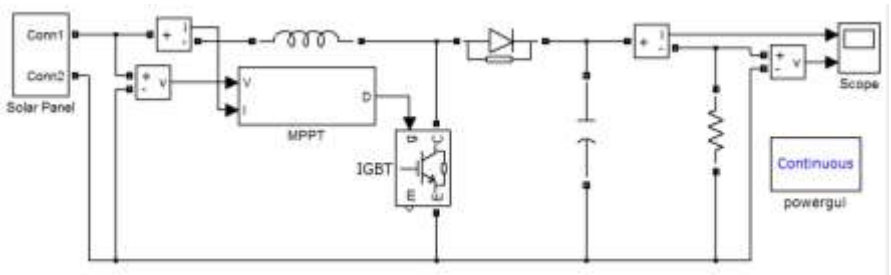

Figure 2. Block Diagram of Test system

The simulation output for the test system using PSO based MPPT algorithm is shown in fig.3 and simulation output for the test system using DE based MPPT algorithm is shown in fig.4

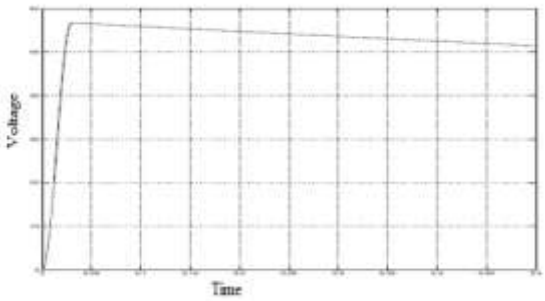

Figure 3. Simulation Output for PSO Based System

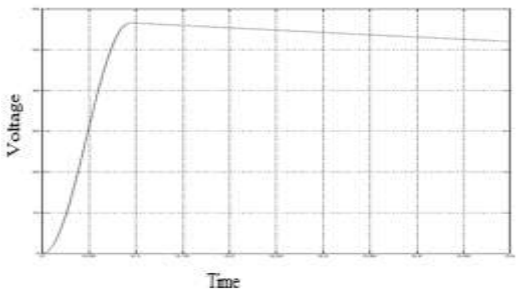

Figure 4. Simulation Output for DE Based System

Comparison Output

	Voltage
Particle Swarm Optimization Algorithm	**52 V**
Differentia; Evolution Algorithm	**50 V**

VI. CONCLUSION

Thus the test system has been designed and the simulation results have been obtained for the PSO based MPPT and DE based MPPT algorithms. The results represent the PSO based MPPT is better than the DE based MPPT system. The system can be developed for MPPT based on other optimization techniques and can be compared with the system results.

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