International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 6 Issue 3, March-April 2022 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

Analysis and Implementation of Particle Swarm Optimization Technique for Reduction of Power Loss in Microgrid

Nilesh Pandurang[1], Pramod Kumar Rathore[2]

[1]Student, [2]Assistant Professor,
[1,2]RKDF College of Engineering, Bhopal, Madhya Pradesh, India

ABSTRACT
This article will concentrate on renewable energy sources. The hybridization production is made up of two sources combined: solar and wind energy. The purpose of constructing a hybrid connection is to totally absorb both sources and boost network resiliency. The software MATLAB was used to make the art. The focus here is on constructing a modest micro-grid for a specified region that will be supplied with power generated only from renewable sources. The connection of this full tiny micro grid with the state utility system results in reliable and sustainable power. During disturbances, producing and matching loads may be disconnected from the utility to protect the load of micro-grids while without affecting the transmission grid's integrity. This capacity to create energy and distribute it independently to a particular small area need has the potential to give more local reliability than the whole power grid.

KEYWORDS: *Solar (PV), Wind Power, boost converter, AC-DC Hybrid Systems, Battery backup, Microgrid*

How to cite this paper: Nilesh Pandurang | Pramod Kumar Rathore "Analysis and Implementation of Particle Swarm Optimization Technique for Reduction of Power Loss in Microgrid" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-6 | Issue-3, April 2022, pp.250-256, URL: www.ijtsrd.com/papers/ijtsrd49512.pdf

IJTSRD49512

1. INTRODUCTION

Traditional energy sources are rapidly disappearing. Furthermore, energy costs are growing, and renewable energy sources provide potential alternatives. They are numerous, pollution-free, widely distributed, and recyclable. Its high installation costs and poor conversion efficiency are disadvantages. A micro-grid is a small-scale power source, such as a wind turbine, solar array, or diesel engine, that is linked to fulfilling the requirements of local communities. To be more specific, it is a distributed generation (DG) network that provides energy as a group or individually [2]. A micro-grid incorporates renewable energy sources such as wind turbines and PV arrays that are connected to traditional utilities through a bidirectional converter. This is known as the grid-connected mode, as opposed to the autonomous island mode, in which the traditional utility is isolated from the micro-grid. In reality, to construct a Hybrid Micro-Grid, a micro-grid may incorporate AC sources, DC sources, or both. (3rd) Energy sustainability is the most difficult task, and microgrids hold great promise for improving power supply dependability. The micro grid is an energy sector that improves the usage of dispersed energy production utilizing renewable energy sources such as wind, tidal, biomass, and solar, among others. "A micro grid is a set of linked loads and dispersed energy sources inside clearly defined electrical boundaries that function as a single controlled entity with regard to the grid," according to the US Department of Energy. As electrical distribution technology advances throughout the twenty-first century, several developments will emerge that will alter the needs for energy supply. And these changes are being pushed by both the demand side, where more energy availability and efficiency are wanted, and the supply side, where the integration of distributed generation and peak-saving technologies is required. Power systems are now experiencing major changes in operating conditions and needs, mostly as a result of deregulation and an expanding population. Because of the increased growth of DGs in power systems, controlling the power of various DGs and utility grids has become a key challenge. Micro grids have been a widely acknowledged idea in this industry for the improved connection of DGs to power networks. AC micro grids have been created to correspond to the conventional power system, and a number of studies have been conducted, notably on the question of power sharing of parallel-connected sources. Because the majority of renewable energy sources generate dc power or require a dc link for grid connection, and as a result of increasing modern dc loads, dc micro grids have recently emerged due to their advantages in terms of efficiency, cost, and systems that can eliminate the dc-ac or ac-dc power conversion stages and their associated energy losses. The bulk of electricity systems, however, have alternating current (AC). Microgrids continue to dominate, and exclusively DC microgrids are on the rise. As a consequence, current research has focused on linking AC microgrids with DC microgrids and using the advantages of both microgrids. The idea is to connect alternating current and direct current microgrids using a bidirectional ac/dc converter to create a hybrid ac/dc microgrid in which alternating current and direct current energy sources and loads can be flexibly integrated into the microgrids and power can flow smoothly between the two microgrids.

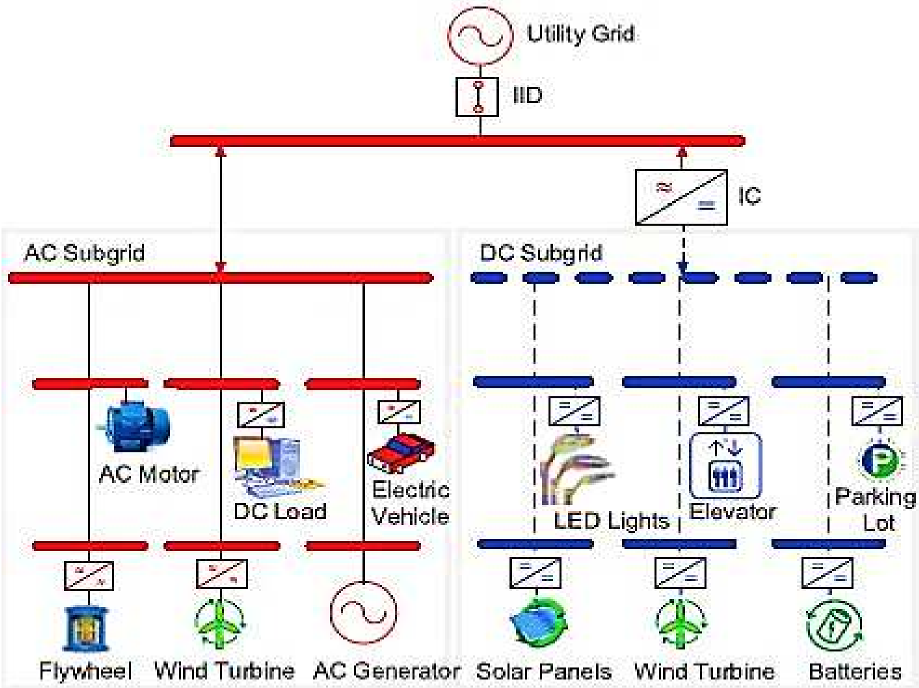

Fig. 1. simple architecture of AC/DC HMG

As shown in Fig.1, both ac and dc sub grids are connected to the main grid through an Interlinking converter, which can be either a voltage source converter (VSC) or a back-to-back converter. The interlinking converter represents a corner stone of the ac/dc HMG. In general, the primary function of the interlinking converter is to control the transfer of power between the ac/dc micro grids. In islanding operations, the IC is also designed to ensure:

1. Equal loading of the ac/dc sub grids based on their own rating
2. Minimal load shedding and generation curtailment in the entire hybrid system.

2. METHODOLOGY

The objective function is evaluated by Newton trust region method and the iterative power flow solution can be best described by the flow chart shown.

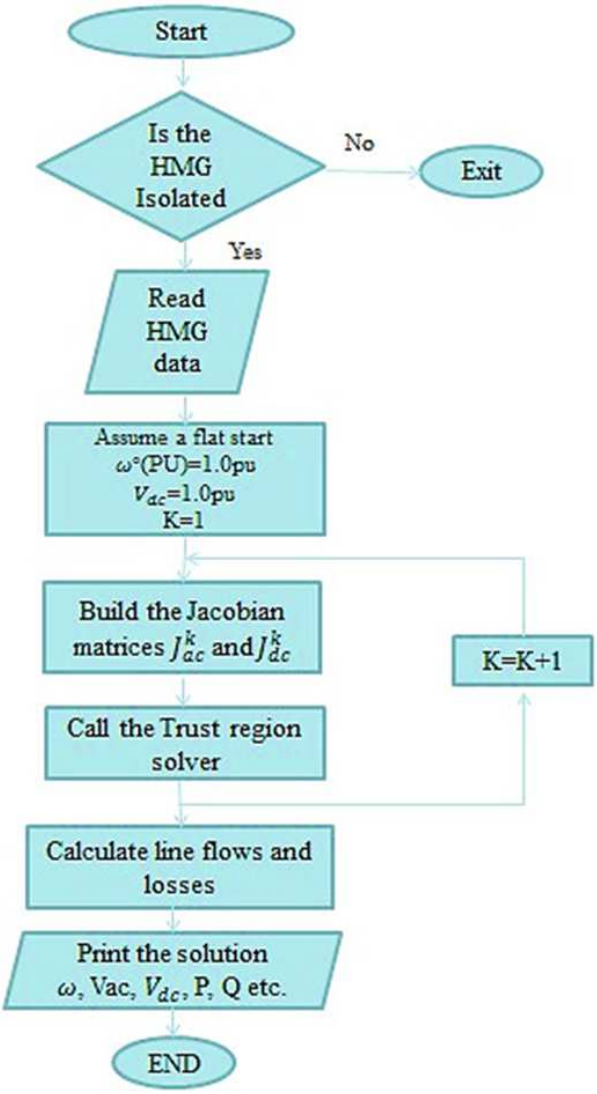

Fig. 2FlowchartofACDCHMGpowerflowalgorithm

Particle Swarm Optimization (PSO)

In computational science, **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. It solves 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.

PSO is originally attributed to Kennedy, Eberhart and Shi and was first intended for simulating social behaviour,[4] as a stylized representation of the movement of organisms in a bird flock or fish school. The algorithm was simplified and it was observed to be performing optimization. The book by Kennedy and Eberhart describes many philosophical aspects of PSO and swarm intelligence. An extensive survey of PSO applications is made by Poli.[6][7] Recently, a comprehensive review on theoretical and experimental works on PSO has been published by Bonyadi and Michalewicz.

PSO is a metaheuristic as it makes few or no assumptions about the problem being optimized and can search very large spaces of candidate solutions. However, metaheuristics such as PSO do not guarantee an optimal solution is ever found. Also, PSO does not use the gradient of the problem being optimized, which means PSO does not require that the optimization problem be differentiable as is required by classic optimization methods such as gradient descent and quasi- newton methods.

Particle swarm optimization (PSO) is a population based stochastic optimization technique developed by Dr. Eberhart and Dr. Kennedy in 1995, inspired by social behavior of bird flocking or fish schoolingPSO shares many similarities with evolutionary computation techniques such as Genetic Algorithms (GA). The system is initialized with a population of random solutions and searches for optima by updating generations. However, unlike GA, PSO has no evolution operators such as crossover and mutation. In PSO, the potential solutions, called particles, fly through the problem space by following the current optimum particles. The detailed information will be given in following sections. Compared to GA, the advantages of PSO are that PSO is easy to implement and there are few parameters to adjust. PSO has been successfully applied in many areas: function optimization, artificial neural network training, fuzzy system control, and other areas where GA can be applied.

Genetic Algorithm and PSO

Most of evolutionary techniques have the following procedure:
1. Random generation of an initial population
2. Reckoning of a fitness value for each subject. It will directly depend on the distance to the optimum.
3. Reproduction of the population based on fitness values.
4. If requirements are met, then stop. Otherwise go back to 2.

From the procedure, we can learn that PSO shares many common points with GA. Both algorithms start with a group of a randomly generated population, both have fitness values to evaluate the population. Both update the population and search for the optimum with random techniques. Both systems do not guarantee success. However, PSO does not have genetic operators like crossover and mutation. Particles update themselves with the internal velocity. They also have memory, which is important to the algorithm.

Compared with genetic algorithms (GAs), the information sharing mechanism in PSO is significantly different. In GAs, chromosomes share information with each other. So the whole population moves like a one group towards an optimal area. In PSO, only gBest (or lBest) gives out the information to others. It is a one -way information sharing mechanism. The evolution only looks for the best solution. Compared with GA, all the particles tend to converge to the best solution quickly even in the local version in most cases.

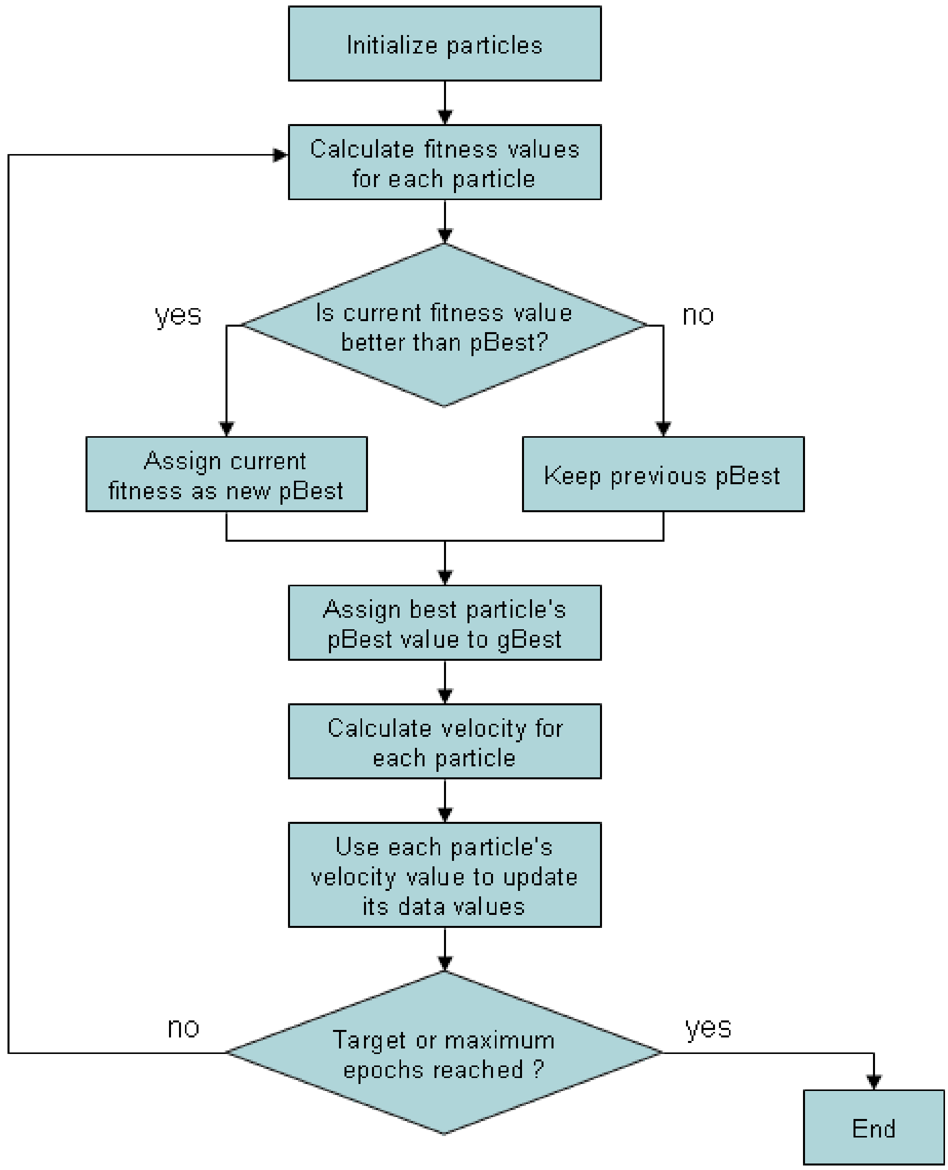

Figure 3 Flow diagram illustrating the particle swarm optimization algorithm.

Results

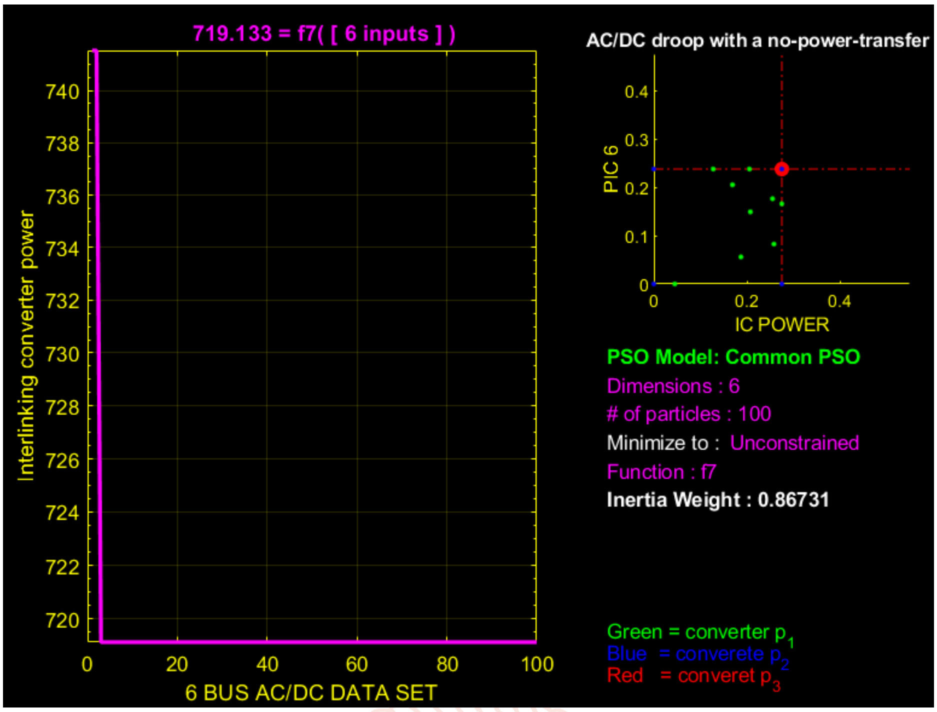

Figure 4. Result of applied 6 Bus data set outputs.

BUS DATA SETS

0.9645	0.00	000	00	0.2752
0.9631	-0.0057	1.3781	1.4097	0.778
0.9653	0.0115	00	0	0.4128
0.9648	0	0	0	0.2630
0.9505	0	0.833	00	0.2556
0.9681	0	000	0	0.237

BUS DATA SETS RESOURCES.

MG	Bus #	Bus Type	DR Type	$\lvert V\rvert$ (p.u.)	δ (deg.)	P_L (p.u)	Q_L (p.u.)	P_{DR} (p.u.)	Q_{DR} (p.u.)	η_p (%)	η_q (%)
AC	1	Droop	DG	0.9645	+0.0000	—	—	0.2752	0.1895	77.40	71.07
	2	PQ	–	0.9631	−0.0057	1.3781	1.0497	0.7778	0.5833	—	—
	3	Droop	DS	0.9653	+0.0115	—	—	0.4128	0.2779	77.40	69.49
DC	1	Droop	DS	0.9648	—	—	—	0.2630	—	70.46	—
	2	P	—	0.9505	—	0.8333	—	0.2556	—	—	—
	3	Droop	DG	0.9681	—	—	—	0.2378	—	63.71	—
						$\sum P_L$	$\sum Q_L$	$\sum P_{DR}$	$\sum Q_{DR}$	P_{Loss}	Q_{Loss}
						2.2114	1.0497	2.2222	1.0507	0.0108	0.0010
IC	IC #	AC Bus	DC Bus	V_{ac} (p.u.)	V_{dc} (p.u.)	Δe (p.u.)		P_{ic} (p.u.)	Q_{ic} (p.u.)	η_p (%)	η_q (%)
	1	1	1	0.9645	0.9648	0.0462		−0.0462	—	4.62	—
	2	3	3	0.9653	0.9681	0.0404		−0.0404	—	4.04	—

Table: 1 AC-DC DATA set source

Interlinking Converter power	719.1328
Power loss	0.00039
Peak load power	2.77877
Maximum iteration	100

Table: 2 Parameter control table

Conclusion

In the MATLAB/SIMULINK environment, a hybrid microgrid for power system configuration is simulated. The present endeavor is focused on grid-tied hybrid grid functioning. Models for all converters are built in order to maintain a stable system under different loads and resource circumstances, and the control mechanism is also explored. The MPPT algorithm is used to extract as much power as possible from DC sources and to coordinate power exchange between DC and AC grids. Although the hybrid grid may simplify the processes of DC/AC and AC/DC conversions on a single AC or DC grid, there are a number of practical challenges to establishing the hybrid grid on the current AC-dominated infrastructure. The decrease in conversion losses and the inclusion of an extra DC connection influence the total system efficiency. The hybrid grid has the potential to provide customers with more consistent, high-quality, and efficient power. A hybrid grid may be feasible for tiny, isolated industrial units that use both PV systems and wind turbine generators as their principal power source.

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