Solar Electrical Model PV Modeling Using Gaussian Roulette Wheel Selection (GRWS) Algorithm

V.SEKAR, J.MAHADEVAN, N.GURUSAKTHI
Dhanalakshmi Srinivasan College of Engineering and Technology
Chennai, India

ABSTRACT

Full shading/Partial shading of PV arrays is one of the most discussed and worked upon problem in the subject of solar photovoltaic as it reduces the output power and famous a couple of peaks in the PV and I-V characteristics. As, a end result the modules have to be reconfigured to get a most power output. This paper provides an optimization primarily based method for Independent Power Producers linked modules in a PV array. The physical locations of the modules stay unchanged whilst the electrical connections are altered. The proposed method utilizes, Gaussian(standard deviation)Roulette wheel determination (GRWS) as an optimization method, which offers the closing connection matrix for the new electrical interconnection which extracts the maximum strength from the PV array. This is carried out to attain uniform color dispersion at some stage in the panel. The proposed approach has been examined and simulated in MatlabSimulink environment beneath partial shading conditions.
Keywords: Solar cell, PV system, Energy optimization etc.

I. Introduction

The energy wanted for technological know-how age is the most important topic. With the growing technology, the fast make bigger of world population reasons an expand of strength consumption. Because of having the terrible results of new kinds of power to the human health, the use of the oldfashioned electricity production methods and depleting of the energy sources, lookup of new and renewable electricity sources has become more common. Obviously the Sun is the most herbal energy source, having both, the least harm to the nature and being without difficulty accessible for everyone. For the motive of our country's geographical location, we are luckier than most of other countries for having sun energy. Solar cells are the photovoltatic (PV) gadgets changing the Sun strength without delay into the electrical energy. The present day and voltage supplied via the smallest structure unit of PV structures are very low. To get a usable energy, a PV panel have to consist of a lot of solar cells linked in collection or in parallel to each other. Panels can additionally be linked in sequence or in parallel with others. By connecting the panels serially, the voltage vary can be increased; and by connecting the panels in parallel,the cutting-edge capacity can be increased as well. PV panels constitute the PV array through serial or parallel connections; and PV array in query can be named "solar PV array" [3, 4]. The electrical power produced by way of PV panels can be affected by using the radiance, the temperature, the attitude of the surface and through shading. Even if the PV panels are identical, each PV panel nonetheless can produce one of a kind modern and voltage. The PV panel with lower energy produces lower current at serial connections, and lower voltage at parallel

connections. Thus, output of the PV device is affected negatively. Each PV panel's modern-day and voltage distinction have to be taken into account at suitable circuit design for photo voltaic arrays [5, 6]. A study [4], associated to shading effect of PV panels, has determined the top of the line connection mannequin at exceptional stipulations of temperature and radiation. Another find out about has examined the strength production for distinct PV panel connection sorts by using the usage of the Function of GA algorithm on MATLAB platform [7]. Study [8] investigates the effect of mismatch losses of PV panel array located on the massive region via using the Sudoku method. In this study, specific PV panel array connections, depending on the selected inverter sorts were investigated and visualized using MATLAB programming language. The PV panel substitute in the photo voltaic array and the optimization of circuit plan is finished the usage of genetic algorithm. The parameters (radiance, temperature, attitude of floor and partial shading) affecting the PV panel's output are covered in the PV device to get extra environment friendly results.

II. LITERATURE REVIEW

Ali Al-Karaghouli, L.L. Kazmerski [13] addresses the requirement for PV nearby planetary group to control a wellness facility in the rustic regions in southern Iraq. The creators utilized HOMER programming PC model to figure out the most financial framework. They proposed framework with an each and every day heap of 31.6 kWh which is made out of 6-kW PV modules, 80 batteries (225 Ah and 6 V), and a 3-kW inverter. The mixture commencing cost, net current cost, and cost of energy delivered from the framework are 50,700 US$, 60,375 US$, and 0.238 US$/kW h, separately. The investigation demonstrates that the cost of electricity created from the diesel generator is 4 instances extra noteworthy than that delivered from the PV framework, which highlights the gain of making use of this framework in faraway regions. The examination likewise demonstrates that utilising this little PV framework alternatively than a diesel generator can hold the arrival of 14,927 kg/year of CO_2, 36.8 kg/year of CO, 329 kg/year of NOx, 4.08 kg/year of HC, 30 kg/year of SO_2, and 278 kg/year of suspended particles. Souissi Ahmed, Hasnaoui Othman, Sallami Anis [14]; the creators proposed an enchancment arrangement of a half and half association of sustainable electricity source by using using the Homer programming for far flung stages in Tunisia. The Hybrid frameworks consist of mixture of more than a few vitality sources like wind/battery, PV/battery, wind/PV/battery, wind/PV/diesel/battery. The climatic statistics are unique for the area of Hawaria in Tunisia. The ideal setup of the half breed framework wind/PV/diesel/battery planned for reliable load provide and moreover considered the meteorological statistics changes is reasoned from two perfect designs chose: (wind/PV/battery) and (diesel/battery). For the wind/PV/battery the best setup is made with the aid of 8 kW board PV, 2 wind turbine, 118 batteries and 12 kW manipulate converters. The underlying cost and the operation price 165.450 US$, 2.102 US$/yr separately. The mixture internet present fee 189.559 US$ and the fee vitality created 0.540 US$/kWh. For the diesel/battery the perfect layout is shaped with the aid of 5 kW diesel generator, 18 batteries and 2 kW manipulate converters. The underlying cost and the operation value 11.934 US$, 10.707 US$/yr, individually. The combination net existing fee 134.747 US$, the value vitality delivered 0.382 US$/KWh and the diesel 11.269 L.

For the wind/PV/diesel generator/battery with heap of 85 kWh/d the best diagram is created by eight kW board PV, 2 wind turbine, 118 batteries, 5 kW diesel turbines and 12 kW manage converters. The creators demonstrates that the mix of a diesel generator, as buck-up source, with

the half of and half of wind/PV/battery framework is the best answer for assurance the stable provide besides intrusion of the heap below the climatic data change. The perfect measuring of the half of and 1/2 wind/PV/diesel/battery framework is discovered from the two perfect designs picked: (wind/PV/battery) and (diesel/battery). ZeinabAbdallah M. Elhassan, Muhammad FauziMohd Zain [15]; talked about the proficient arrangement of reasonable sustainable electricity supply for local utilized and its mixture fee in Khartoum in Sudan. The creator's method used to be the accumulation of the imperative data of daylight based totally radiation, wind pace and different required data information, and after that the creators utilized HOMER programming to build up the cross breed streamlining reenactment. The proposed load is 54 kWh/d, and 5.3 kW as a pinnacle.

The fee of the PV module which include establishment has been thoughtful as 220 SP/W for Sudan. The price of turbine with tower and establishment has been considered as 96000 SP/turbine. For load greater than 1 kW, turbine from southwest wind manipulate (demonstrate: W175, limit, three kW) has been considered at the fee of 200000 SP/turbine with tower and establishment. The operation and upkeep cost has been taken as 500 SP/year. Moreover 800 kW converter and 3500 batteries have been viewed as and the aggregate net current value 19.1 US$. The creators determined that it is best to utilize wind/PV combine framework for 50 houses as an alternative than single domestic framework. Moreover if the turbine fee diminishes in Khartoum the widespread value of vitality would be low. The copy comes about show that the usage of inexhaustible generators, for example, wind generator and PV decreases the working fees making use of a second fee type of lodging at Khartoum state. Deshmukh et al. [16] depicted techniques to model 1/2 and half of sustainable strength source framework (HRES) segments, HRES outlines and their assessment demonstrating that the move breed PV/wind vitality frameworks are ending up distinctly progressively famous and highlighted the troubles identified with entrance of these vitality frameworks in the existing appropriation arrange as it offers possibilities of fusing in energy era capacity to decorate manipulate quality, due to the fact of the scattered era.

Wei et al. [17] confirmed productive white natural mild emanating system in view of excepted with higher luminance and iridescent proficiency and this biutilitarian device with electroluminescence (EL) and PV exhibitions is promising to be utilized as white presentations or backdrop illumination supply later on as it can be charged by sun based vitality thru extra mechanical assembly free of work and can likewise be utilized as an optical sensor to UV light. Ito et al. [18] introduced techniques of TiO2 film manufacture for coloration sharpened solar primarily based cells that consists of of pre-treatment of the working image terminal by using TiCl4, varieties in layer thickness of the easy nanocrystalline-TiO2 and use of a topcoat light-scattering layer and moreover the grip of a adverse to reflecting movie to the anode's surface bringing about a alternate effectiveness of global air mass 1.5 (AM 1.5, 1000W/m2) daylight based mild to electric manage extra than 10% .

Jaber et al. [19] constructed up a PC copy model of the habits of a photovoltaic (PV) gas-turbine half of breed framework, with a compacted air store, to determine its execution and in addition to expect the mixture vitality transformation productivity and determined that go breed plant delivers round 140% more energy for each and every unit of gasoline expended contrasted and evaluating usual gas turbine vegetation and decrease charges of poison discharges to the air per kWh of energy created. K.R. Ajao, O.A.Oladosu and O.T. Popoola [20]; utilized HOMER

programming for enhancement to detect the fine cash saving advantage of half breed - solar oriented impact era with appreciate to make use of taken a toll in Nigeria. The money saving advantage examination of a wind/sun powered go breed framework used to be completed utilizing HOMER programming and correlation used to be additionally made with utility supply. Focal framework power is the slightest pricey alternative but may additionally now not be available to most u . s . a . household gadgets a long way from the matrix. Henceforth it is necessary to furnish these areas from disengaged manage sources. The proposed framework utilized (0.05 – 0.4 kW) PV board with (0.4 kW DC) FD arrangement wind turbine, (0.1 – 1.5 kW) converter, and (200 Ah/12 V, financial institution estimate: 1-8 batteries, imaginative and prescient 6 FM200D) battery. The creators end result acquired from the development gave the underlying capital value as 3,455 US$ while working price is sixty nine US$/year. Add up to internet existing fee (NPC) is 4251 US$ and the price of vitality (CoE) is 1.74 US$/kWh. The creators determined that, the half of and half of framework have a compensation returned time of around thirty-three years and at modern-day expenses. Bhuiyan et al. [21] focused the monetary matters of remain solitary photovoltaic strength framework to take a look at its achievability in far flung and provincial areas of Bangladesh and contrasted inexhaustible generators and nonrenewable mills with the aid of deciding their life cycle price utilizing the approach for internet present esteem examination and validated that existence cycle value of PV vitality is lower than the value of vitality from diesel or oil mills in Bangladesh and therefore is monetarily achievable in faraway and rustic zones of Bangladesh. Alazraki and Haselip [22] surveyed the effect of little scale PV frameworks brought in homes, colleges and open buildings in the path of the most current six years beneath the PERMER (Renewable Energy Project for the Rural Electricity Market) cosubsidized by a scope of open and private sources and the shape of cash associated endowments has empowered these remote provincial corporations to get a strength grant supplanting prevalent vitality sources.

III. System description

Fig. 1 shows the equivalent circuit of a realistic PV cellphone where the generated present day Iph is proportional to the irradiation. The recombination losses are represented by the diode connected in parallel to the modern supply in reverse direction. This is due to the fact the recombination modern flows in the contrary route to the light generated current. The V-I equation of a easy solar model can be given by using the following expression:

$$I_m = I_{ph} - I_d \left[\exp\left(\frac{q(V_{pv} + I_m R_s)}{nkT}\right) - 1 \right] - \left(\frac{V_{pv} + I_m R_s}{R_{sh}}\right) \qquad (1)$$

Where, q is the cost on electron, n is the number of cells in series, ok is the Boltzmann regular and T is the absolute temperature (Kelvin), Iph is the photoelectric current, Im is the contemporary generated via the module.

A variety of PV cells linked in collection represent a PV module. Typically a module incorporates 36 PV cells linked in series. The resistance presented with the aid of the solar cells in the path of the present day go with the flow is denoted via Rs. Resistance presented to the leakage modern is represented through Rsh. The photoelectric modern is a characteristic of the brief circuit current and can be expressed as follows:

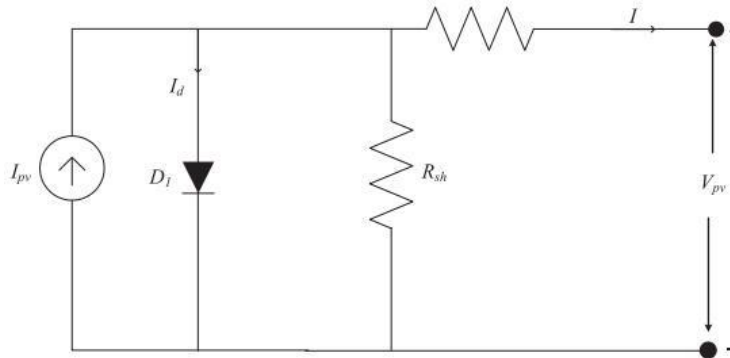Figure 1: Equivalent circuit: practical PV cell

$$I_{ph} = I_{sco}\left(\frac{G}{G_0}\right)(1 + \alpha(T - T_o))\left(\frac{R_s + R_{sh}}{R_{sh}}\right)$$ (2)

Where is the short circuit current of the module at standard insolation Go (1000 W/m²) and wellknown temperature To (25 1C) and α is the module's temperature coefficient for the current. The PV modules are modeled the use of the equations cited above.

IV. Proposed method

Genetic algorithms (GAs) are a subclass of what are regarded as evolutionary algorithms [13]. These are computational fashions that mimic herbal evolution in their sketch and implementation; i.e. they are based totally on survival of the fittest. GAs differ from conventional search techniques in that they operate on a coded parameter set of the solution, are global in their search, make use of a cost feature that does no longer contain derivatives and subsequently employ pseudo-probabilistic guidelines and no longer deterministic ones. Genetic algorithms have been used in recent years in fixing optimization issues in science and engineering applications [14, 15]. Implementation of GAs involves making the following preliminary decisions.

➢ Solution encoding. This includes coding a feasible answer (individual) as a string of variables the use of some alphabet, e.g. binary {0, 1}. Individuals are likened to chromosomes and variables to genes. A chromosome (solution) is composed of quite a few genes (variables).
➢ Evaluation function. This determines the health rating attached to every chromosome (solution). The greater this score, the greater is the threat of an person (solution) being selected for reproduction.
➢ Initial population generation. Generation of the preliminary population (set of feasible solutions) can be random or from known approximate solution(s).
➢ Selection criterion. Methods of selecting individuals for replica are numerous and include roulette wheel sampling, stochastic general sampling, event selection, elitism, sigma scaling, rank choice etc.

(5)   Recombination/reproduction. This is done thru two genetic operators, particularly crossover and mutation. A range of variations of crossover are in use such as single-point, multi-point or uniform crossover. Insingle-point crossover the place binary encoding is used, a locus (bit location) is randomly chosen. Bits after that locus are exchanged between two chromosomes to create two offspring (new solutions).

Mutation on the other hand involves randomly flipping some of the bits in a string (chromosome). A very small probability is commonly connected to incidence of mutation at every bit place (e.g.

0.001). This operation is carried out to make sure that new areas of the solution are explored.
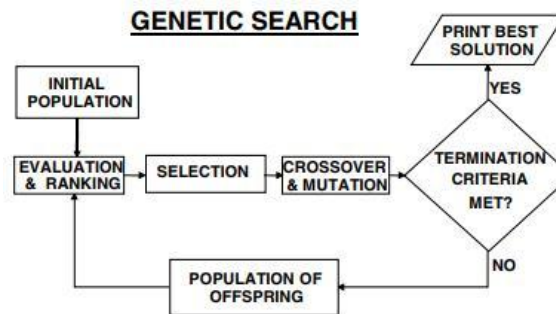

Figure 2: GA flowchart

(6) Termination criteria. The algorithm can be terminated if the maximum number of generations (iterations) is achieved, or convergence of the solution is attained (i.e. all solutions yield the same fitness value or differ by less than a specified tolerance). Based on the decisions made above, the search algorithm can be invoked. Figure 2 illustrates a typical GA flowchart.

4.1. Proposed implementation for solar telephone parameter extraction

A MATLAB implementation of a GA [16] is used to extract the parameters of a photo voltaic cellphone below illumination.

- Implementation of the GA for photo voltaic phone parameter extraction was once primarily based on the following.
- Solution encoding: floating factor representation.
- Parameter precision: $10-6$.

Evaluation function: based on equation (3), expressed as

F (Iph, ISD1, ISD2, Rs, Rsh, n1, n2) = $-$ IL $-$ Iph + ID1 + ID2 +Ish(3)

Where, all the variables are as defined before. (The GA software used [16] was developed for maximization of a multivariable function. Thus, $-$f2(...) was once used as the value function and the highest quality answer is attained when f2(. . .) = 0.)

Initial populace generation: randomly generated and of dimension ten.

Selection criterion: roulette wheel.

- Crossover: simple crossover with two calls per generation.
- Mutation: boundary mutation with 4 calls per generation.
- Maximum range of generations: 25.

A set of values for the V-I characteristics serves as the enter records for the GA. The parameters that are

extracted through optimization are Iph, ISD1, ISD2, Rs, Rsh, n1 and n2. Theoretically, the value function must be zero

for any I–Vpair when the actual value has been determined for each and each and every parameter. Before invoking the genetic algorithms, a search vary has to be set for the solar mobilephone parameters. Each vary was centred on the particular fee of the parameter and assorted via ±5 to ±100%. The deviation between the extracted and the specified values of the parameters is then computed for each range. This is carried out due to the fact current extraction strategies have distinct degrees of accuracies in figuring out photo voltaic cellphone parameters.

The following steps are the pseudo-code for the Gaussian algorithm

- ➢ Step 1: Start with N Gaussians.
- ➢ Step 2: Set a imply and popular deviation for every Gaussian.
- ➢ Step 3: Calculate the probability of all Gaussians. Likelihood is a statistical index which measures the distance of true points from the formal Gaussians based on the chosen suggest and widespread deviation.
- ➢ Step 4: If the possibility has now not improved due to the fact that the remaining iteration, stop the algorithm. Otherwise try distinct values for imply and preferred deviations for every of the Gaussians.

Gaussian can be described as a random process, where any finite subset of this system has a joint Gaussian distribution [14]. Gaussian applies a distribution over features that are specified by using a imply characteristic and a covariance feature as proven in Equation (4).

$$( ) =(\text{ two } (\text{ two }), \ (\text{ two }, \text{ two two }')) \qquad (4)$$

The mean function, ( ), is commonly defined to be zero and the covariance (, ′) defines the prior homes of the functions considered for inference The in the covariance represents the kernel feature which tasks the data into a higher-dimensional feature space to enlarge the computational energy of the algorithm [16].

V. RESULT

A standard photo voltaic module consists of sequence connection of photo voltaic cells to get virtually utilizable voltage. A quantity of such modules are linked collectively in sequence and parallel to get the requisite power. From the outcomes and inferences from this project, it is concluded that there is a substantial strength loss due to non-uniform illumination of a collection string. The energy generated via relatively illuminated cells is wasted as a warmness in the poorly illuminated cells. So, care must be taken to see that all the cells connected in collection get hold of the same illumination below exclusive patterns of shading. Such a care will give a better safety to the array and at the equal time the complete power output will additionally be higher.
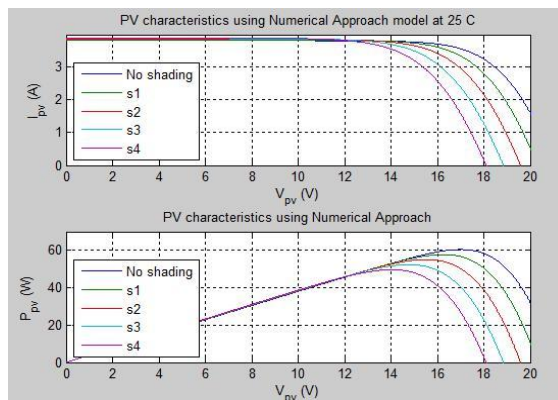
Figure 3: PV characteristics using Numerical approach model at 25° and GRWS

Above determine provides the optimization of PV module electrical characteristics the use of Gaussian roulette wheel selection (GRWS). A mathematical modelling is used to characterize the electrical characteristics of PV module. A 60 W, 20 V, PV module is used in this work. Under steady temperature and one of a kind photo voltaic irradiance were tested to the PV module the usage of GA, its electrical characteristics proven in curves and compared to the data sheet and a reference and also three-d layout as function of each solar irradiance and temperature proven and discussed. The result shows that the evaluation of simulation results the usage of GA with current-voltage and power-voltage curve illustrates a excellent correlation, if the temperature consistent and photo voltaic irradiance extend will reason the quick circuit current, open circuit voltage, most strength and effectivity increase.
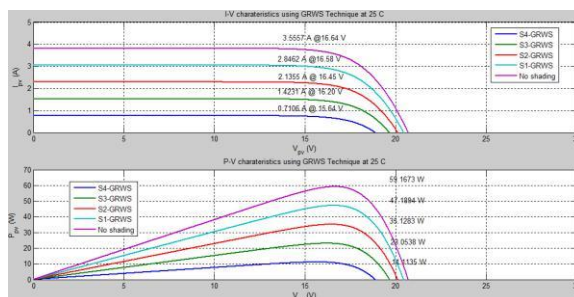

Figure 4: l-V characteristics using GRWS technique at 25° C

The I-V curve of a PV characteristic is a scale-up of the I-V curve on multiple cells, as illustrated in Figure 4.
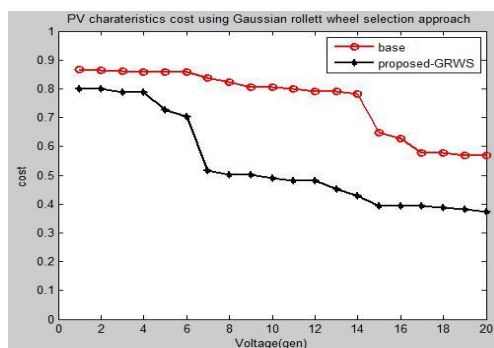

Figure 5: comparison between Base and proposed-GRWS over Cost and Voltage

As we can see that the proposed technique (voltage) receives much less fee as compare to Numerical system. Photovoltaic (PV) strength systems have been extensively applied in industrial and domestic facilities. Electrical Energy Storage (EES) systems are obligatory in standalone PV structures for non-stop strength supply. In this work the effectivity and robustness enhancement strategies for PV systems beneath partial shading have been investigated. Partial shading due to moving clouds and shadows of nearby barriers on the PV module array causes vast effectivity degradation, considering the fact that shaded and non-shaded PV modules have massive discrepancy in their most electricity points. Use of by-pass diodes for every PV module may additionally mitigate the bad impact from partial shading. However, this technique alone might also nevertheless face severe power effectivity degradation induced with the aid of the power loss due to parasitic results in the EES elements underneath variable incoming energy from the PV modules. Hence, this work investigates the effect of shading on photovoltaic cells.

VI. Conclusion

This paper provides a new Gaussian Roulette wheel selection primarily based electrical array reconfiguration approach inorder to increase power generation of a photo voltaic PV below partial shading conditions. In this method, the electrical interconnections of the modules are altered whereas the bodily area of the modules stays unchanged. The proposed strategy targets at equalizing the man or woman row currents with the aid of minimizing the wellknown deviation. This makes it viable to reducethe mismatch losses and extract maximum power from array underneath any environmental conditions. For the given shading pattern, it is determined there expand in the most strength using the proposed technique. The gadget overall performance is analyzed, and it is proved that the proposed approach yields better outcomes as compared to the existing interconnection scheme.

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