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Solar System Array by Fuzzy Logic based on MPPT Algorithm

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Abstract: ***In recent times a huge attention has been given on development of proper planning In this paper we present a top dimension perspective on forefront status of Closed circle ID system the use of PID Controller from explicit creators. The proportional– integral– subsidiary (PID) controller is the most extreme comprehensively ordinary controller inside the business bundles, specifically in strategy enterprises in light of fabulous expense to profit proportion. In this paper we focus on MPPT based solar system performance enhancement by use of fuzzy logic controller's designs optimized by particle swarm optimization (PSO). We have described about different latest A.I. techniques that has been hybrid with fuzzy logic for improving PV array based solar plants performance in recent time. The artificial intelligence technique applied in this work is the Particle Swarm Optimization (PSO) algorithm and is used to optimize the membership functions for maximum power point tracking rule set of the FLC. By using PSO algorithm, the optimized FLC is able to maximize energy to the system loads while also maintaining a higher stability and speed as compared to P& O based MPPT algorithm.***

Keywords: ANN, GHG, PhotoVoltaic, Fuzzy.

I. INTRODUCTION:

Regardless of the course impacts of the money related emergency that have influenced each part, in shifting degree and geology, the excitement for supportable influence source keeps making with a feasible model. By new report of the UNEP (United Nation environment Program), the energy for economical power source rose 5% in 2008 displaying undeniably the foundation of new systems for electric power age and confirms that this region tends to now a standard essentialness adventure. The atmosphere of the mind blowing soundness of economical power source is the consequence of the support of the definitive and societal responsibility towards liberal activities to coordinate natural change by decreasing Green House Gasses (GHG), lessening their reliance on oil subordinate supply and making imperativeness security a key need. No ifs, ands or buts, the current monetary and sparing emergency may have maintained off the eagerness on the oil subordinate essentialness and driven down costs. Be that as it may, the world end is as yet actuated, that is just a compact deferral.

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It gives that there is a lethargic hazard structure imperativeness emergency, and will include a not all that awful lift for the improvement of the supportable power source period.

To stand up to this threat from resources weariness, sun based imperativeness is seen as an overwhelming choice rather than unsustainable essentialness use in made and making countries. In the midst of the latest two decades, the musicality of the execution of sun fueled residence using PhotoVoltaic (PV) sheets or Concentrated Solar Power (CSP) headways has revived in the countries organized in the daylight based essentialness belt, paying little respect to their prohibitive costs. By International energy Agency (IeA) daylight based power will grow up to 20-25% by 2050. The IeA has in like way predicted that, by 2050, the PV and CSP structures will be able to make 9000 TWh of force and reduce the yearly CO2 transmissions by perfect around 6 billion tones [3].

Daylight based essentialness asset examination and site fittingness for gigantic PV ranches executions is influenced by various segments which can be depicted in three basic classes: Technical, economical and environmental. These segments rely upon the geographical zone, biophysical characteristics and socio-productive foundation of the nation under examination. Notice that the buildup and sand risk portions are just explicit to the area and might not have any sort of impact for different nations with delicate condition. The suitability of the area of a PV habitation is settled in context on the blend with various heaps of the amazing number of segments recorded already. The most insolated regions are inclined to high sensibility. Locale to streets stays away from extra cost of base improvement and basic underhandedness to the conditions. Grounds that have irrelevant quality by virtue of past use and current conditions ought to be studied for potential PV ranches affiliation. PV ranches are especially sensible where the association with the stream electric framework is basic. The way to deal with execute PV cultivates in close closeness to the present cross area and loads shaft decay essentially transmission hardships. Liberal scale PV ranches require level scene or really splash slant that is facing south with not really a 5% reviewed evaluation. The relationship of the PV wherever scale were gotten in the point of view of sensible progress and control of characteristic change, since it works for broadened lengths with low help. PV structures were viewed as advances that have inside and out that truly matters no typical effect, since, they are flawless and calm. Beginning here of view, the execution of PV ranches, should regard the delicate territories under scene and achievement affirmation due to in vogue necessities. Zone of impacts apparent as fundamental hazard zone for PV properties, for example, floods and stormy territory, ought to be kept up a key partition from.

Additionally, zone with abundance of buildup, hardened with the event of mist and fog, will affect the ampleness (pay) of PV living arrangements.

For example, if a sun energized gatherer surface is kept up at a tidiness measurement of 90%, the surveyed yearly catastrophe in pay reach up to 10%. Also, washing with water (standard cleaning strategy) may well fuse restrictive expenses. Sun based essentialness is exceptional as flawless imperativeness in light of the fact that there are no carbon radiations in the midst of its age. With the progress of PhotoVoltaic (PV) advancement, colossal scale structure related PV control plants have been worked the world over beginning late. The union of unending PV generators will have far reaching results not just on the national transmission and age system besides on the dissipating structures. PV will be a basic hotspot for the microgrid (MG). In any case, because of the capriciousness of sunlight based light and including temperature, the power yield of PV plants is nondeterministic and stochastic. The late precedent toward a low-carbon society has enlivened the speedy presentation of PV structures for power age.

II. RELATED WORK:

Ravinder Kumar Khar, S. L. Shimi, S. Chatterji, and Md. Fahim Ansari (2014), [7] according to them sun arranged essentialness, at this moment is considered as a basic source in power age. Power from the sun based imperativeness can be made utilizing sun arranged photovoltaic (PV) modules. The advancement of sun based power segregated from a PV module is of exceptional worry as its productivity is low. The yield force of a PV module is subject to the land zone and environment conditions, for example, daylight based light, shading and temperature. To get most prominent power from PV module, photo voltaic power framework when in doubt requires most outrageous power point following (MPPT) controller. In this work, an adaptable neuro-soft construing structure (ANFIS) based most outrageous power point tracker for PV module has been appeared. To think most outrageous power, a DC– DC help converter is connected between the PV module and the heap. The dedication cycle of DC– DC support converter is offset with the assistance of the ANFIS reference show, so most vital power is exchanged to stack. In light of the unconventionalities of the tracker portion and non-direct nature of photograph voltaic framework, the modernized reasoning based strategy, particularly the ANFIS methodology, is utilized as a bit of this work. With a specific genuine target to watch the most uncommon open intensity of PV module, the ANFIS reference show expressly takes in working temperature and irradiance level as information. The reaction of proposed ANFIS based control structure indicates precision and quick reaction. The age result uncovers that the most outrageous power point is sought after acceptably to vacillate irradiance and temperature of PV module. Reenactment results are given to support the idea. R. Arulmurugan, N. Suthanthiravanitha (2015) [10] as shown by them Harnessing essentialness from no-limit, free sunshine is correct now an interesting issue inside the investigation arrange. The accessibility of unobtrusive sun arranged modules has made it conceivable to assemble sun situated imperativeness at higher ampleness. Photovoltaic (PV) modules have nonlinear characteristics, and in this manner, the strategy for impedance arranging is required. Appropriate impedance arranging guarantees extraction of the most incredible extent of intensity in a PV plan. Two or three tallies that are utilized to work DC to DC converters around the Maximum Power Point (MPP) are spoken to in the creation. Among those calculations, Fuzzy Logic Control (FLC) united with different controllers performs well under halfway shading conditions. This work structures another 5 × 7 overhauled FLC-coupled Hopfield Neural Network (NN) most uncommon after system. A Hopfield NN is utilized to routinely tune the cushy selection limit. Whole segments of a PV appear, a DC– DC buck-reinforce zeta converter and a spread out MPP following controller are acknowledged in a Matlab– Simulink gadget to support the Hopfield NN. The outcomes support the abundancy and execution of the Hopfield NN utilizing the updated cushy framework. The made structure was effectively endeavored on an exploratory model. The fundamental characteristics show the probability and overhauled estimation of the game plan. G. Balasubramanian and S. Singaravelu [11] have shown a Fuzzy Logic Controller for Maximum Power Point Tracking (MPPT) in photovoltaic structure. A direct and careful method for indicating photovoltaic gatherings is proposed. The model and feathery based control systems are joined to shape quick controllers that are progressively accurate and fiery. The model based controller is represented with the true objective that the reference movement for PWM generator of the converter can be consented to accomplish most incredible power period from the photo voltaic system. The proposed cushioned reason controller exhibits better introductions emerged from the P&O and PI MPPT based theory. A MATLAB based appearing and proliferation plan close by MPPT and cushy reason controller is proposed which are fitting for concentrating on the I-V and P-V qualities of a PV show under a non-uniform light and specific temperature. The model has been likely recognized. Areen Abdallah Allataifeh, Khaled Bataineh, Mohammad Al-Khedher [12] have communicated that daylight based power headways have been profitably made and used continuously in various countries that have broad proportion of sun fueled radiation. Daylight based essentialness systems are seen as the most engaging imperativeness sources. Photovoltaic (PV) systems can be used as stay singular structures and can be related with system. Jordan depends transcendently on the imported oil for get-together its essentialness demands. Jordan has a riches proportion of sun based essentialness where parts of Jordan get 300 days of sunlight for every year. This makes the country an incredibly promising spot for sun fueled imperativeness use. The proportion of force made by a PV board depends upon sun situated irradiance falling externally, working temperature, and weight related. A most extraordinary power point tracker MPPT is an electronic DC to DC converter that overhauls the match between the sun situated display (PV sheets), and the battery bank or utility network. They convert a higher voltage DC yield from sun controlled sheets down to the lower voltage expected to charge batteries. The Maximum Power Point (MPP) varies upon irradiance changes, thusly a most outrageous power point following is imperative to keep up the best power regards. The viability of PV plant depends upon inverter efficiency, most outrageous power point following estimation, and the capability of PV board.

The PV adequacy depends upon cell creation, which does not outperform 15%. overhauling capability of PV board and inverter are troublesome in light of development and cost thought. on the other hand, improving estimations of most extraordinary power point tack (MPPT) is practical and can be realized on existed PV system. In this paintings, Po-Chen Cheng, Bo-Rei Peng [13], have displayed a hilter kilter Fuzzy-Logic-Control (FLC)- based Maximum Power Point Tracking (MPPT) figuring for Photo-Voltaic (PV) systems. Two Membership Function (MF) plan rationalities that can update the commonplace feel of the proposed deviated FLC-based totally MPPT strategies are then proposed. The essential system can unexpectedly choose the statistics MF setting regards via techniques for the electricity– voltage (P–V) bend of sunlight hours based totally cells under fashionable test situations (STC). The second framework makes use of the atom swarm streamlining (PSo) method to enhance the statistics MF setting regards. Since the PSo technique must goal and replace a fee farthest point, a price breaking point graph approach that meets the execution necessities of useful photovoltaic age structure (PGSs) is in like manner proposed. By reenactment and initial results, the proposed strayed FLC-based totally MPPT framework has the most noteworthy prosperity appreciate, in like way, it may suitably address the going with charge/following exactness tie separated and the usual chafe and watch (P&O) and symmetrical FLC-based totally MPPT rely.

III. METHODOLOGY:

Maximum Power Point Tracking (MPPT)

In recent years, because of global warming and the rise in crude oil price, countries worldwide have begun to invest heavily in research and development related to renewable energy sources. Among renewable energy generation systems, solar power generation has received the most attention; from small-scale applications (e.g., energy provision to consumer electronics) to large-scale operations (e.g., solar power plants), the scope of solar power applications is broad. However, because the energy conversion efficiency of photovoltaic (PV) generation system (PGS) is low and the cost of solar power generation is higher than that of thermal power generation or nuclear generation, determining how to acquire maximum power from a PGS has become an essential topic. The characteristic curves of a solar cell are nonlinear and depend on the irradiance level and ambient temperature, resulting in a unique current–voltage (I–V) curve. Consequently, the operating point (OP) of a PGS must be adjusted to the extent in which the maximum efficiency of the solar cells can be achieved, and this technique is called maximum power point tracking (MPPT) [14].

The Perturb and observe (P&O) method is the most common MPPT approach applied in commercial PGSs [15]. This method determines the system control commands according to the difference in the power output between the current system state and previous system state. Consequently, determining the perturbation step applied to a system is an essential topic. At the point when a considerable annoyance step is used by a framework, the time required for the framework to track the maximum power point (MPP) and accomplish an unfaltering state is short, yet the measure of force misfortune brought about by the bother is high. By complexity, a little annoyance step can reduce the force misfortune brought about by the bother however diminish the following rate of the framework. This marvel is for the most part known as the exchange off between following speed and following exactness [16]. By and large, MPPT strategies that apply the altered step size strategy are influenced by the exchange off. Thusly, scientists have proposed various variable step size MPPT strategies to ease this difficulty. The center idea of variable step size MPPT is that, when the OP of a framework is far off from the MPP, a considerable annoyance step is acquainted with the framework control, along these lines expanding the following rate of the framework. Then again, when the oP approximates the MPP, a little irritation step is acquainted with the framework control to enhance the adequacy of the framework in accomplishing an enduring state [17]. The variable step MPPT strategies specified in past concentrates for the most part decide the irritation venture as per the oP in the power–voltage (P–V) bend of sunlight based cells. In any case, the trademark bends of sun based cells can change as indicated by the working environment; in this manner, deciding a bother step size appropriate to a wide range of working condition is an essential subject with respect to variable step MPPT. Alternatively, fuzzy logic controller (FLC)-based techniques can be applied to nonlinear systems. Moreover, such techniques do not require accurate system parameters or complex mathematics models to achieve superior control performance. Therefore, FLC-based MPPT methods have become a worthy research topic.

Fuzzy Logic

"In almost every case you can build the same product without fuzzy logic, but fuzzy is faster and cheaper". It is seen that fuzzy logic has been considered as the superset of conventional logic or classical logic. This fuzzy logic has been used to take into account the concept of partial truth, wherein truth values lies between completely false and completely true. Fuzzy logic is discussed in detail in [24][25]. Fuzzy logic concerns the relative importance of precision. How important is it to be exactly correct when a rough answer will do?

Fuzzy Sets:

Consider the contents of box 3 shown in Fig 1 and comment on the statement:

Box 3 is a box of apples. A simple true or false is no longer suitable, and an answer of mostly would be a better answer. Sometimes it is not important to know exactly how many apples are in the box, but only that the box contain mostly apples. This relates to the concepts of precision and significance. Fuzzy sets handle all values between 0 and 1, where 0 represents false and 1 represents true.

Fig 1: Fuzzy set (source Dennis, 2007)

Fuzzy If then Rules:

Fuzzy if-then rules better known as conditional statements can be represented in the following way,

IF A THeN B, here A and B are fuzzy set labels [26]. These A and B are characterized by suitable membership functions. In order to capture the imprecision in the modes of reasoning, fuzzy if-then-rules are often used. This is done so because it plays a very vital role in the ability of humans to make decisions in uncertain and imprecision environment.

To demonstrate this let us take the example given below:

"If pressure is high, then volume is low". Both pressure and volume and high and low are linguistic variables and linguistic values respectively. They have been developed on the basis of membership functions [24, 25]. Another example can be described by using Sugenos's rule, given below:

If velocity is high, then force = k* $(\text{velocity})^2$

here, high in the linguistic label having an appropriate membership function [8][9]. On the other hand velocity is non fuzzy. Both the above rules are being frequently used for modelling. This rule is the inherent part of FIS described in section above.

Fuzzy Inference system (FIS):

FIS , also called Fuzzy Rule Based system. It has 5 stages[24][25] (fig 2):

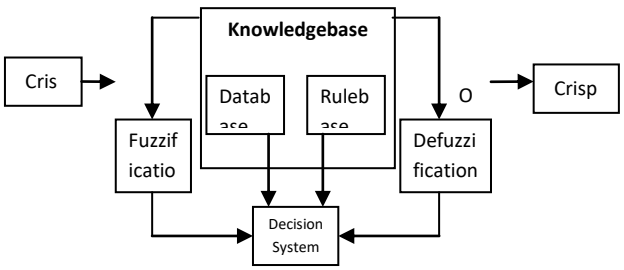

Fig 2: Fuzzy inference system

>Rule Base :- It contains fuzzy if-then rules.

>Database :- It defines the fuzzy set membership functions to be used in fuzzy rules.

>Decision Making Unit :- To be used for making inference operations on the fuzzy rules.

>FuzzificationInterface :- This step helps in converting the crisp ouput into fuzzy ouput .

This fuzzy output has linguistic values.

>DefuzzificationInterface :- To be used for transforming fuzzy output into crisp one.

In general, rule base and data base are collectively known as knowledge base.

The following given below are the steps to be used for fuzzy reasoning byFIS :-

1. This step is fuzzification, which involves comparing the input variables with the premise part so as to get the membership values of the linguistic labels.
2. Next step is to get the weights (firing strength) of each rule, usually done by combining the membership values on the premise part, using T-norm operator.
3. Next based on the firing strength, develop the consequent of each rule.
4. Finally, to add the consequent to get the crisp output, known as defuzzificaation.

FIS are of three types, depending upon the fuzzy reasoning or fuzzy if-then rules.

Particle Swarm Optimization:

Particle Swarm optimization (PSO) is an evolutionary computation technique, which is inspired by flocks of birds and shoals of fish. In PSo, a number of simple entities (the particles) are placed in the space of some problem and each evaluates its fitness as its current location. each particle determines its movement through the space by considering the particle which had the best fitness and the history of its own, then it moves with a velocity. At last, the swarm is liable to move near the best area. The speed and position of every molecule is balanced by the accompanying formulas:

$$V_{id} = WXV_{id} + c_1 Xrand()X(P_{id}-X_{id}) + C_2 XRand()X(P_{ad}-X_{id})$$

$$X_{id} = X_{id} + V_{id}$$

where c1 and c2 are termed the cognitive and social learning rates. These two parameters control the relative importance of the memory of the particle itself to the memory of the neighborhood. The variable rand() and Rand() are two random functions that is uniformly distributed in the range [0,1]. Xi = (Xi1, Xi2, … ,XiD) represents the ith particle. Pi = (Pi1, Pi2, …,PiD) represents the best previous position of the ith particle. The symbol g represents the index of the best particle among all the particles. Vi = (Vi1, Vi2, … ,ViD) represents the velocity of the ith particle. Variable is the inertia weight. The general process of PSo is as follows.

- Do
- Calculate fitness of particle
- Update pbest if the current fitness is better than pbest
- Determine nbest for each particle: choose the particle with the best fitness value of all the neighbors as the nbest
- For each particle Calculate particle velocity according to (1)
- Update particle position according to (2)
- While maximum iterations or minimum criteria is not attained

Since the introduction of the PSO algorithm, several improvements have been suggested. In 1998, inertia weight was first proposed by Shi and eberhart [27]. The function of inertia weight is to balance global exploration and local exploitation. In the following year, Clerc proposed the constriction factors to ensure the convergence of PSo. eberhart and Shi compared inertia weight with constriction factors and found that the constriction factors were better convergence than inertia weight [28].

Dynamic and Adjustable PSO:

In this section, we propose two improved algorithms called Dynamic and Adjustable Particle Swarm Optimization 1 (DAPSO1) and DAPSO2. In DAPSOs, in order to adjust the velocity of each particle, all particles are calculated the distance from itself to the global best position by the following function.

$$\Delta x_{di}=|(x_{di}-x_{gbest})|$$
$$FD_d = Max(\Delta x_{di})$$

wherex_{di} is the position of the i^{th} particle, x_{gbest} is the position of gbest. FD_d is the furthest distance from the particle to gbest. In DAPSO1, the velocity and position of each particle is adjusted by the following formulas:

$$V_{id} = WXV_{id} + c_1Xrand()X(P_{id}-X_{id})+C_2XRand()X(P_{ad}-X_{id})$$
$$ac= rand()*0.5$$
$$V_{new}=\begin{cases} V_{id} * \left(1 + ac_d * \frac{Gene-Iter}{Gene}\right)\frac{\Delta x_{di}}{FD_d} > 0.5 + ac_d \\ V_{id} * \left(1 - ac_d * \frac{Gene-Iter}{Gene}\right)\frac{\Delta x_{di}}{FD_d} < 0.5 - ac_d \\ V_{id} \qquad 0.5 - ac_d <= \frac{\Delta x_{di}}{FD_d} <= 0.5 + ac_d \end{cases}$$
$$X_{id} = X_{id} + V_{new}$$

where X_{id} is updated by the velocity which is adjusted by the distance from particle to the global best and is the adjustment coefficient. DAPSO1 and DAPSO2 differ from the adjusting method. In DAPSO2, the velocity and position of each particle is adjusted by the following formulas:

$$V_{id} = WXV_{id} + c_1Xrand()X(P_{id}-X_{id})+C_2XRand()X(P_{ad}-X_{id})$$
$$V_{id}=\begin{cases} V_{id} * \left(1 + \frac{rand()}{4} * \frac{Gene-Iter}{Gene}\right)\frac{\Delta x_{di}}{FD_d} > 0.5 + ac_d \\ V_{id} * \left(1 - \frac{rand()}{4} * \frac{Gene-Iter}{Gene}\right)\frac{\Delta x_{di}}{FD_d} < 0.5 - ac_d \\ V_{id} \qquad 0.5 - ac <= \frac{\Delta x_{di}}{FD_d} <= 0.5 + ac \end{cases}$$
$$X_{id} = X_{id} + V_{id}$$

IV. RESULT AND DISCUSSION:

In this section we will demonstrate the result for FIS rule application that is optimized for achieving MPPT control. The PSO algorithm is designed to generate a fuzzy membership function for input values of error and change in error.

It has been observed that at different choice of membership function range of e and ec the output power varies and it is very typical to search the emin ,emax, ecmin and ecmax values at which designed MF can give highest output power by achieving the duty cycle at an optimum value of near about 0.8.

We have selected a particle swarm of size n=10 and the algorithm is run several times for maximum number of iterations value of birdstep=20.

The PSO generates the n particles in terms of randomly initialize value of emin ,emax in between -30 to 30 and ecmin , ecmax in between -50 to 150. Hence each particle represent a dimension space of 4 parameter [emin, emax, ecmin, ecmax].

Hence initially a 4xn matrix of n particles is generated for in a limited range with an equal dimension size of velocity associated with each parameter.

The main PSO algorithm calls the fitness function named as 'tracslq.m' to design the FIS structure for given particle parameters by adding fuzzy input vectors membership functions by equally partitioning the error in range emin to emax and change in error by ecmin to ecmax, after generating the MF for each particle in name of linguistic variable given as NB, NS, Z, PS and PB.

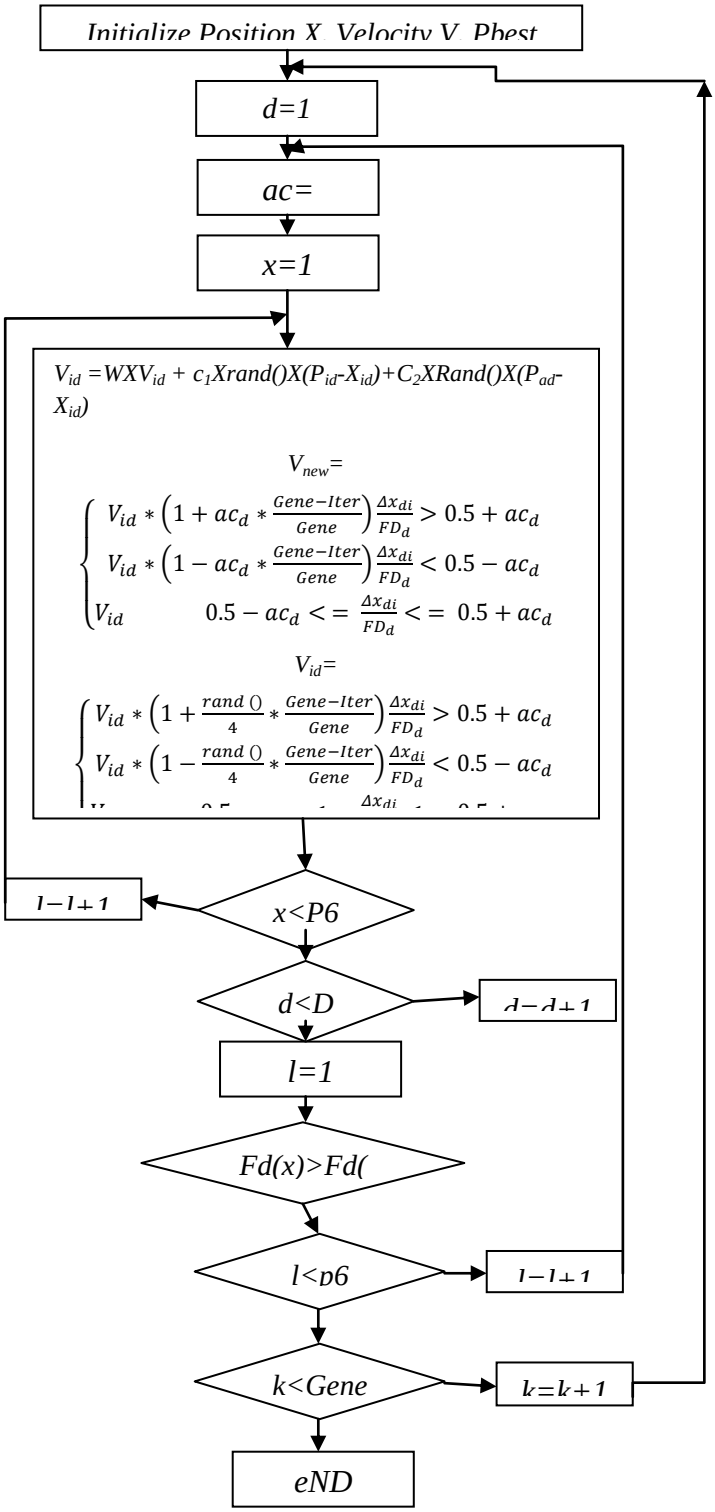

Fig. 3: Flowchart of DAPSO.

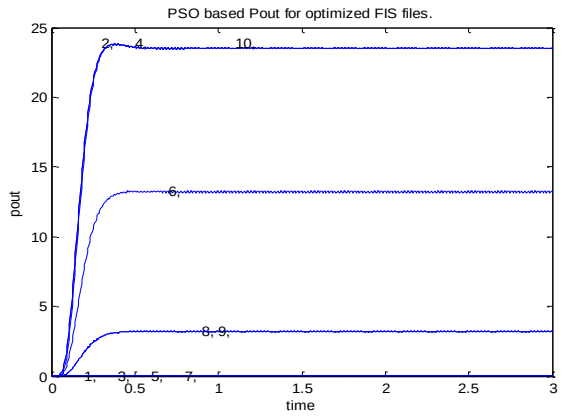

Fig 4:Collective results of output power (pout) for all finally optimized particle fuzzy MF.

The particle parameters are updated by the velocity value to generate a new particle population to find the updated performance. In the figure 4 the optimized parameter of final membership fiunctions are shown for running of our PSO Fuzzy membership optimization algorithm for n=10 particles and for number of iterations of iter=20.
In figure 4 we can see that particle 2,4,8 can give maximum power output in the range of 24Watt (approx.) and particle 1.3,5,7 has insignificant pout while 8,9 has very low pout and 6 has pout at value of 6watt (approx.).
The MF of each optimized particle whose pot performance are collectively shown in figure 4

Table 1: Optimized MF range

id	e min	e max	ec min	ec max	Avg Duty Cycle
1	$-1.14x10^{9}$	$1.12x10^{9}$	-99.23	44.37	-0.0071193
2	10.146	16.975	-106.43	20.284	0.53279
3	$-1.73x10^{11}$	$1.69x10^{11}$	-74.246	14.368	-0.075052
4	10.448	16.481	-70.657	0.25122	0.54807
5	0.54807	1926.8	-138.64	-1.1961	-0.13072
6	-5966.4	24494	-85.511	27.18	0.32855
7	$-4.8 x10^{10}$	$4.5 x10^{10}$	-78.105	-11.432	-0.17995
8	15.628	17.688	-180.38	2.4604	0.54638
9	-613.59	1825.7	-82.077	36.544	0.21738
10	-0.48983	21.292	-138.32	4.5537	0.54169

Out of n=10 particle position the algorithm select the best particle which have highest on average duty cycle value hence from above average duty cycle values the particle at id 4 has average duty cycle of 0.54807.
Thus the algorithm selects the best Particle id as 4 having best particle parameters of values:
eminemaxecminecmax

10.448 16.481 -70.657 0.25122

The algorithm finally shows the plot of MF parameters , pout values and respective duty cycles at different time instants.

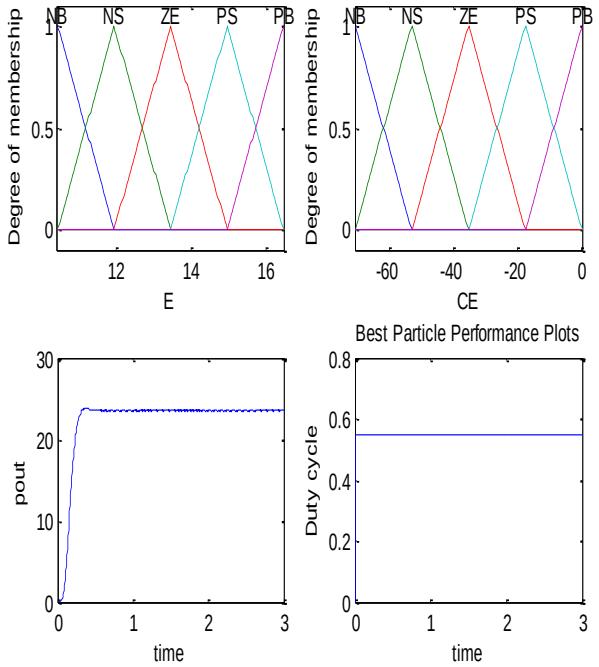

Fig 5: Plots for best particle parameters based MF and the pout and duty cycle performance for PSO Fuzzy MPPT approach result.

Figure 6 demonstrates the plot of all the power output of different MPPT approach for the solar cell array. All the simulink models are run for three sec. one by one and their output powers along with the duty cycle values are transferred at Matlab workspace to generate the multivariable plots. The blue line is the pout (top) of P& O based MPPT model having maximum power of 20 watt approx. reaches it peak at time 0.4 seconds approx. But the pout fluctuates multiple time and takes long time to stabilize even at small dip in the duty cycle as we see the duty cycle in bottom figure (blue line).The P& O MPPT has duty cycle of 0.8 at most of the time there are two small value dips in duty cycle but it creates large amount of oscillations that stays for long time in Pout. The red line is the plot for fuzzy based controller the pout has maximum value of 18Watt that is less than the pout line of P & O based MPPT and it is too much rippling duty to frequent amendment and fluctuations in fuzzy rules. We can observe that the duty cycle in bottom plot (red line) never crossed the duty cycle above than 0.5 however fuzzy rules are made to access max. duty cycle of 0.8.It makes the reduction in Vout value and T_{on}time thus the average current also reduces thus the Pout is reduced considerable.

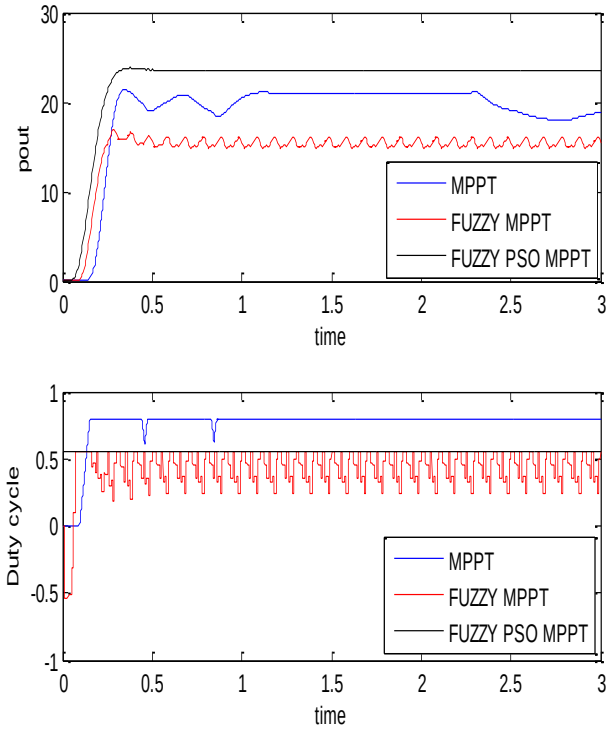

Fig 6: Comparative plot for output power and duty cycle range obtained for P&O MPPT, Fuzzy MPPT and PSO optimized fuzzy MPPT.

The third plot is for PSO optimized input MF of fuzzy controller input for the finally selected best particle having highest average duty cycle (see figure 4.19).The Pout (top subplot, black line) has Pout pf 25 Watt higher than the both fuzzy controller (red) and P& O MPPT hence the best particle MF values gives highest out power for solar array. The oscillations in this case are nil hence the Pout performance are ripple free hence shows reduction in harmonics it has been also observed that there is no peak overshoot in PSO optimized fuzzy MF output power plot.

The last advantage that can be observed in the pout plot is that the fastest performance (i.e least rise time) is in the Pout of PSO optimized fuzzy MPPT and the duty cycle in this case is also not goes above than 0.5 to 0.6 range but still the obtained power output is better than P&O based MPPT approach.

V. CONCLUSION:

The PSO optimized fuzzy logic controller based results are compared with the conventional techniques such as P&O and normal fuzzy controlling methods which shows that the power output by the PSO optimized fuzzy scheme gives higher power than both methods. The design consists of electronically gate controlled IGBT based buck converter interfaced with photovoltaic arrays for DC-DC converter development operating at MPPT conditions. By applying the gate pulse width IGBT switching are controlled with appropriate duty cycle evaluation by MPPT algorithm related fuzzy rules. The proposed scheme based PSO optimized fuzzy controller results also have an advantage that the Pout has ripple free performance and it is faster than fuzzy and P&O controlling scheme. In future the obtained investigation and simulation results of the proposed PSO optimized can be validated on real time experimental setup based practical's to shows that the simulation results closely agree with the experimentally obtained results for validating the experimental power circuit and control circuits of the dc-dc converter.

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