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# Comprehensive Review on Soft Computing Based Maximum Power Point Tracking System Under Complex Operating Conditions

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***Abstract***— Renewable energy sources are the route to regular increases in fuel prices as well as the global warming and environmental pollution. Fossil fuels (gas, oil, coal) and nuclear power plants are the main sources of global energy generation. The utilisation in household fossil fuels like CFC, $CH_4$, $O_3$, but emit especially carbon dioxide into the atmosphere. Although a small amount (90 grammes of carbon dioxide equivalent per kilowatt-hour) of carbon is released from the nuclear power plant, radioactive waste remained active for a millennium, potentially a source of environmental pollution. The planet is, however, facing an alarming energy crisis with declines in the reserves of fossil fuels and the close of ageing plants. Scientists and engineers are looking for clean, renewable energy from the aspect of global warming and natural gas deficiency. The best option is solar power. Since sun rays never reserve and decrease In our atmosphere, on the other hand, the benefit of solar radiation is free to us. Scientists are continuously trying to increase efficiency and better solar cell materials in modern research areas for the advancement of the manufacturing technology for solar cells. The grid connected PV system is a system where the grid is connected to the PV system. Interactive utilities are responsible for AC. The grid-connected device manages high power applications and it is difficult

to store this huge amount of power in the battery. Stand-alone system is divided into several categories according to the type of load, costs, availability of resources and load requirements. Independently of the electric power grid, stand-alone PV systems are designed to work.Among the existing renewable energy sources, photovoltaic solar energy has highlighted by its rapid growth and accepted worldwide. However, photovoltaic systems and their performance is related to several factors, such as temperature, angles and panels, among others. Thus, the implementation and operation is aware of photovoltaic generators require the use of a MPPT. This work proposes and develops an MPPT algorithm based on in fuzzy logic, capable of making the system operate at the maximum power point even under varying working conditions, increasing efficiency. The aim of this paper to present a comprehensive study on design simulation and analysis of fuzzy logic based maximum power point tracking system. The study has been helpful in understanding the technological aspects and challenges in the implementation of the fuzzy logic and adaptive neuro fuzzy based maximum power point tracking system for solar photovoltaic system.

**Keywords:** DC-DC power converters, photovoltaic cells, maximum power point tracker, multilevel and single-phase inverter, Wind Energy, Solar PV, Grid Connected Energy System

## I. INTRODUCTION

In view of the growing world demand for energy,the use of fossil fuels has been widely debateddue to pollution and other environmental impacts causedfor the consumption of non-renewable energy. The greenhouse effect andglobal warming, consequences of combustion burningfossil fuels, have a serious impact on life, due to thesignificant climatic changes observed in recent yearsyears. In addition, there is a consensus that availabilityof fossil fuels for energy use tends todecreasing, which compromises safety and autonomyglobal ethic energy. This scenario has raised awarenesscountries in search of alternative sources ofable to supply their energy demand in asustainable.Among the existing renewable energy sources, energyphotovoltaic solar has stood out for its fastgrowth and accepts global action, since currentlyrepresents a significant part of the energy matrixsome countries. However, photovoltaic systems havelow and science and your income is relatedvarious factors, such as temperature, radiates, anglepanels, among others. Being subjected to variationsclimatic conditions throughout the day, implementation and operation e -aware of photovoltaic generators require the use ofa Maximum Power Transfer Follower system.

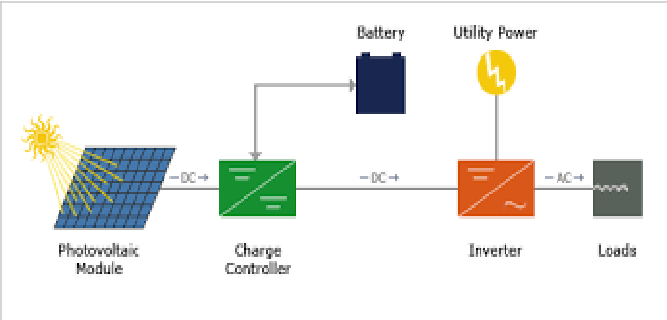


**Figure 1.1: Grid Connected Solar PV System**

The inverter is used to convert the direct current (DC) generated by the solar panel into a load of alternating current (AC). Today, many investors on the market are based on battery connections and network systems. Investors need to determine the magnitude of the expected power level to be processed and are compatible with the conditions on the network side. Other components include JS mounting systems, wiring, switches, disconnectors and system monitors. These components have not been studied in detail. The use of DC cables should at least maintain high resistance losses and costs [39]. For the central inverter, there is also a junction box between the matrix and the inverter fuse to protect against voltage overload. In a network system, the grid itself is like an infinite energy store. Excess energy can be supplied to the grid.

## II. RELATED WORKS

A novel hybrid MPPT technology based on FSCC and P&O was proposed in Hadeed Ahmed Sher, et-al. in 2014. The approach proposed uses the difference in power and voltage as inputs, which have simplified the calculation significantly.

Authors have addressed previous papers focused on traditional P&O, artificial intelligence such as Fuzzy, Neural network and ANFIS. The system architecture and hybrid strategies based predominantly on FOCV and P&O are more complex. The authors suggested a new FSCC and P&O fusion-based hybrid technique. The proposed MPPT hybrid works better than the conventional P&O algorithm under changing irradiance. The proposed algorithm oscillates around the MPP in constant irradiance but has fewer power oscillations compared with the P&O method, and in cases of irradiance changes it utilises the FSCC and hits the MPP nearer than the P&O method more easily. When an irradiation shift is observed, the FSCC acts. Step I helped reach near MPP by FSCC MPPT and stage II was a standard P&O method which perturbed and observed changes in PV power; the proposed algorithm was divided into two phases. Simulation research showed that it has less power loss oscillations under steady state than traditional P&O

Joydip Jana, et-al, developed an FPGA-based charge controller based on maximum solar panel power point tracking in 2014. The designed controller controls the solar panel output power and the battery charge current. Buck converter was used as dc-dc converter by the authors. The developed controller uses the MPPT algorithm for perturbation and observation (P&O) and the dc-dc converter function cycle was modified. The MPPT algorithm was implemented on an FPGA based digital platform within the established controller. Authors provided the proposed algorithm's flowchart, which implements only the first and second phases of battery charge.

Kinattingal Sundareswaran, et-al , 2014 implemented a new MPPT fireflies algorithm to quickly track GMPP in part-shaded pv arrays. Two different configurations of PV arrays under partial shading conditions were tested and the proposed system was compared with the conventional perturbing and observation process (P&O) and optimization of the particulate swarm (PSO) process under similar conditions. Authors addressed several previous works, which lead to a higher computing charge and lower tracking speed, when oscillations occur in the output power before reaching GMPP. The proposed work was aimed at developing an FA based tracking scheme for GMPP in a photovoltaic system under PSC (part-shedding conditions).

The new GMPPT Algorithm (VWS) for string-based PV systems to define the global power peak (GMPP) in shading conditions has been proposed by Mutlu Boztepe, et-al. in 2015. Authors addressed previous works that did not work for all approaches since they were planned for uniform solar irradiation. These traditional MPPT methods are optimised for single peaks only and can converge to local peaks rather than world peaks, causing major system output decreases. Additional power circuits were needed, e.g. for dynamically reconfiguring pvmodules according to shading pattern, a dc / dc converter in sequence, a distributed MPPT concept, an integrated dc / dc converter module, a multilevel converter, an MPPTs connected in parallel and power electronics equaliser, etc.

A charging controller based on FPGA maximum power point tracking for solar panels was developed by Omar Abdel-Rahim, E-L, in 2014. The designed controller controls the solar panel output power and the battery charge current. Buck converter was used as dc-dc converter by the authors. The developed controller uses the MPPT algorithm for perturbation and observation (P&O) and the dc-dc converter function cycle was modified. The MPPT algorithm was implemented on an FPGA based digital platform within the established controller. Authors provided the proposed algorithm's flowchart, which implements only the first and second phases of battery charge. Regulated by the cyclone FPGA, the PV panel calculates the solar watts produced by the input voltage or current through the port of analogue to a digital converter, measures the load side voltage and power and produces the signal to increase, decline or disable the converter. The converter also measures the load side voltage and current. Matlab / Simulink was used to develop the simulations circuit of the proposed device, and several experiments were performed with changing irradiance. The simulation features I-V and P-V were presented. The results showed that the established controller operates at very close range to the maximum power at various solar radiance levels and draws 95% of the power it will produce at the highest power point.

In order to achieve full power from the PV module under PSC, Xu Di, et-al, 2014 proposed a simple GMTT method based on interval shortcut current. Different researchers addressed the earlier work with disadvantages about complexity, additional circuit specifications, and GMPP tracking failure. Simple GMPPT methods based on current short-circuit interval are provided to eliminate these authors. There was discussed GMPPT mathematical modelling. The GMPPT method proposed was based on the standard MPPT method, and no shadowing occurred if the short-circuit current remained unchanged for each interval. The GMPPT control system was based on the boost converter. The GMPPT control method flow charts in partially shaded conditions were shown with simulation graphs. The simulation model of the 2 x 2 PV array was shown and booster converter was used as the main circuit based on the average state space procedure. Simulation results review reveals that the proposed method provides significant advantages regarding simplicity, simple implementation and fast convergence and minor adjustments near the maximum power point.

The new asymmetrical photovoltaic power point tracking (MPPT) (PV) algorithm for the generation photovoltaic system (PGS) is proposed by Yi-Hsun Chiu, et-al, 2014. The approach proposed uses the difference in power and voltage as inputs, which have simplified the calculation significantly. Authors addressed prior research by several investigators, which established and implemented a number of MPPT procedures, but also show a certain balance between the tracking speed of insolation changes and the tracking accuracy. Authors have proposed on the basis of literature that FLC (fuzzy logic control)-based MPPT has better performance control. In place of error and an error deviation, inputs that greatly simplified computing, authors had suggested an FLC dependent MPPT technique in which the input was used as a power variation and voltagle variation. Asymmetrical membership feature was used in order to boost dynamic efficiency. The power step of the PV system was a boost converter and the proposed algorithm was implemented on the dsPIC (DSC) dsPIC33FJL6GS502 digital signal controller. The Authors had submitted a block diagram of the proposed methods, a table comparing the methods to MATLAB / Simulink, and a table of fouzzy rules. Result analysis revealed, in comparison with the traditional FLC-based system, that the asymmetric FLC-based MPPT decreased tracking time by 38.1% and tracing accuracy improved by 0.03%.

Md. Nasim Imtiaz Khan, et-al, has developed and simulated an powerful and cost-effective photovoltaic ( PV) device charging controller. The authors addressed the analysis of recent works showing P&O using the Hill Climbing algorithm, but to achieve the optimum power point this takes a great many iterations. The authors suggested a charge controller MPPT algorithm that would be quicker, more effective than the standard algorithm, and that the charge variations were not affected. Based on SEPiC topology, the built load controller circuit was designed for a 75 W solar panel. The technique used here calculates proportional power instead of real input power to track MPP. Two key sections are used in the proposed algorithm. First, the input voltage was calculated by a sensor and the input voltage product and the corresponding operating cycle were determined.

K. L. Lian, et al , 2014 has proposed hybrid method by combining PSO optimization with P & O algorithm. Several methods were proposed for MPPT, including the P, O and INC methods (Incremental Conductance Method) of most commonly used algorithms. Those methods evolve in order to understand the same essential concept of power gradient as regards current or voltage. The key problem associated with P and O method is that they appear to converge to single local limit which is only acceptable under isolation condition further they are affected by hotspot problem .Author has presented a comprehensive literature survey associated to the algorithms .Several soft computing techniques including neural network , fuzzy logic and PSO has been integrated with MPPT algorithms to keep efficient track on dynamic I-V characteristic and able to track global maximum point. In

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conjunction with the literature review author, the optimization of PSO-based MPPT was demonstrated to be more efficient in GMP-tracking but was slow and delayed with search space increase. In answering this question author, a PSO-P&O algorithm with low search space, non-limited particulate speed and rapid convergence has been proposed.

D. S. Karanjkar, et al, 2014 presented simulations of disruption and observation in real time and comparative studies, incremental efficiency, fluid logic, neural network and adaptive MPPT-based neurofuzzy inferential systems (ANFIS). The ANFIS controller with two inputs and one output was developed in the suggested work. Based on the Sugeno inference model, a fluffy rule basis was produced in this controller. The training data were similar to the NN-based MPPT design. The ANFIS edit tool of MATLAB was used to design the ANFIS controller with two neurons in layer 1 and 14 neurons in the fuzzification layer. A theoretical algorithm used in MATLAB / SIMULINK was used in the calculation of Pmax. All the above methods, built in Matlab, were presented by the authors. The comparison table of various methods was presented by the authors and the graphs obtained from simulation under rapid change in radiation were presented based on monitoring performance, steady state and dynamic behaviour.

M.Latha Devi, et-al, 2014 introduced Single Ended Primary Inductance Converter (SEPIC) Modeling and Simulation of Incremental Conductance (InC Cond). The approach proposed includes only voltage and current calculation. Authors had presented the mathematical modelling of PV panel and SEPIC converter. The proposed MPPT Incremental Lead algorithm increases efficiency and monitors the sun's maximum power. This method computes the maximum power and monitors directly the extracted power from the PV by adjusting the duty cycle in the self-lift SEPIC converter. The authors had given the simulation diagram of control circuit, control circuit of Inc-Conductance system using Simulink, Flowchart, Graphs and comparison tables. The results showed that the voltage produced by the SEPIC self-lift converter was higher than the SEPIC converter. The proposed method offers various benefits: efficient monitoring, high response and well controlled energy. The proposed method offers different advantages.

Abolfazl Halvaei Niasar, et-al, 2015 has developed a method to conjugate the simple P&O MPPT technique with sun tracker based on light sensors. The proposed sun tracker was composed by a two-degree mechanical mainframe that supports the PV and allows movement in two axes. Authors' had addressed prior work for MPPT which was focused on voltage or current control (VMMPT and CMMPT), Hill climbing (HC), Perturbation and Observation (P&O), Incremental conductance system (InC), Array reconfiguration, Fuzzy logic control, Neural network, Ripple correlation control (RCC) and Current sweep. These methods are different from each other in terms of convergence speed, effective range, hardware implementation, required sensor cost and so on. Among them, P&O was considered by authors because it's not related to solar cell parameters, favourable result and relatively easy implementation.

Ali Chikh, etc., 2016 has developed an optimal MPPT based on the solar photovoltaic ( PV) Adaptive neuro-fuzzy model (ANFIS). Authors had addressed previous work by different researchers in which MPPT methods require information on the array voltage , current, and environmental parameters, in some cases, which is a difficult task resulting in an increased and complex hardware with high failure probability and noise measurements. In order to achieve a solution, the authors have developed an optimal MPPT to compute the instantaneous conductance and the array relation conductance. The first one was done using the array voltage and current, while the second one, which was a function of the array junction current, measured using an adaptive neuro-fuzzy (ANFIS) solar cell model.

Giovanni Cipriani, et al . , 2017 has proposed a revised Inc-Cond MPPT approach which could allow PV plants to operate under PSC (Partial Shading Condition) with the true MPP (Maximum Power Point). Authors addressed previous work for the MPPT technique, which based on the HC, the P&O and Incremental Conductance process, in

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which MPP controls were not accurate enough as they carried out steady-state oscillations and methods based on fumigating logic or neural networks were fast and accurate.

Makoto Uoya, et-al, suggested a one-dimensional Newton Raphson monitoring method for the PV device MPP. Authors addressed previous work in which the I-V computing time was long and convergence was not assured. Authors have proposed a quick and accurate method of calculation to compare MPPT using 1-D Newton-Raphson method to resolve this challenge. Under any irradiance conditions including partial shading, the proposed method quickly calculates the operative point of the PV array for the specified voltage. On average, just 29.7% was estimated for the proposed method as a traditional Newton-Raphson method. The proposed approach was presented with mathematical modelling. A PV array consisting of 16 PV modules were taken into consideration in the MPPT simulation, including four series-connected and four parallel blocking and bypass diodes. A flowchart, comparison tables, diagram of circuits, graphs taken from simulation had been presented by the author. The results of the simulation of the system were contrasted with those of the conventional method including the trajectories of the operating points and the total performance of the pv array energies, and calculated time using the proposed method was shorter than with the traditional one. Not only PV arrays, but also general electric circuits designed by series and parallel connexions of each electric element can be used for the proposed process.

In order to optimise the individual subpanel, Edgar Marti-Arbona et al. 2019 has presented maximum power point tracking sub panels which eliminates the panel diodes bypass. Authors had addressed work by several researchers beforehand in which resonant condensers were used parallel to the subpanel but a complex device cabling was needed. Other approaches are used to boost control and reduce installation demands by the individual PM (power management) for each sub-panel. These systems do not increase the output voltage, the serial connexions required to achieve the input voltage of the inverter. To eliminate these authors, a pm unit was presented, which enables parallel panel connexion to be possible by increasing the power of each substructure and the output voltage. The engineered device focuses on reducing the size and reliability of the individual converters (e.g., electrolytic condensers). There are four converters on every MPPT subpanel: one for each sub-panel MPPT (total of 3) and one for the output voltage power. The Subpanel Converter maximises output power to allow a higher output power under partial shading and other malfunctions in comparison to an MPPT panel for each subpanel.

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## III. FUZZY LOGIC BASED MPPT SYSTEM

Maximum power point system is most essential component of charge controller which is essential to operate the photovoltaic system under maximum operational efficiency by load matching and maximum power transfer from source to load..Thus according to the distinction in the solar radiation condition and load condition, the MPPT control following the perfect working voltage is required.Figure 3.2 discuss the I- V and P-V characteristics of photovoltaic module..[14]

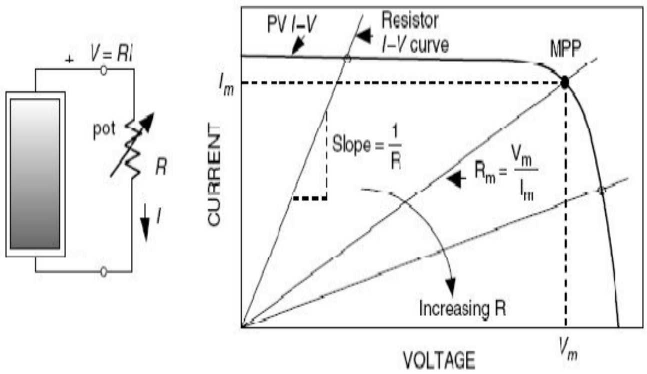


**Figure 3.1: PV Model with Resistive Load**

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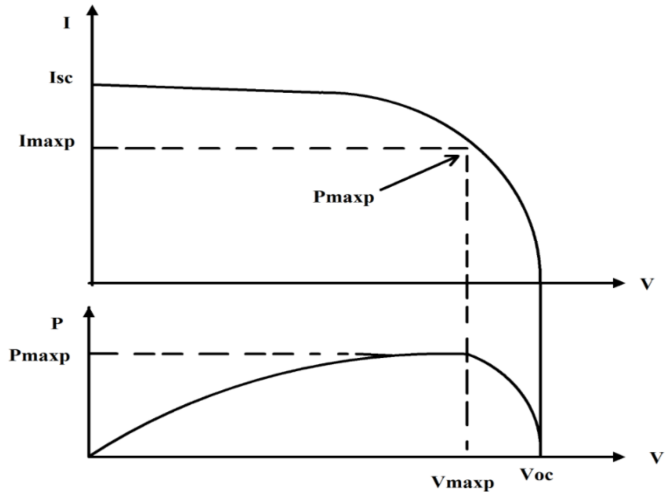


**Figure 3.2: Characteristics of a PV Module**

Figure 3.2 denotes the variation in P-V and O-V characteristics of the photovoltaic module with respect to irradiation and temperature. It is evident that there is rapid decrease in short circuit current due to change in irradiation and there is rapid change in voltage due to change in temperature, the change of irradiation and change of temperature cannot be avoided and it is related to dynamic behavior of characteristics of solar photovoltaic system.The point related to maximum power in the characteristic curve is known as maximum power point it is denoted as maximum power point (MPP).[10]

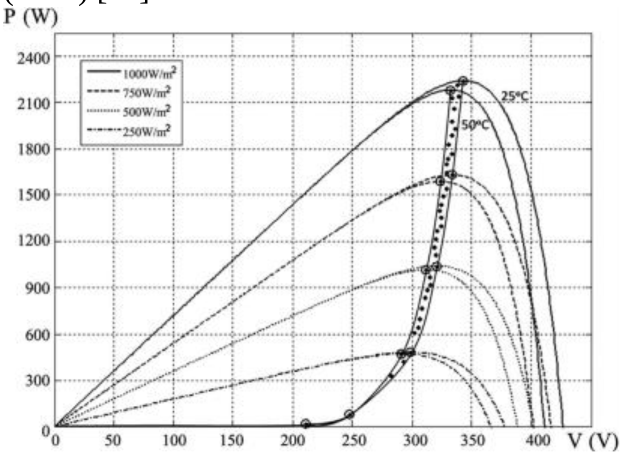


**Figure 3.3. Effect of Irradiation and Temperature on Characteristics of a PV Module**

$V_m$ and $I_m$ are voltage and current associated with this maximum power point is known as the important value of concern at the MPP. The situation related to dynamic behavior of solar photovoltaic system relates to the complexity to find the optimum operating point of the photovoltaic system.[08]

Table 1. Specification of ICA 100PV Module

| Parameter | Symbol | Value |
|---|---|---|
| Maximum Power | $P_{max}$ | 100W |
| Voltage at max power | $V_{mp}$ | 17.5V |
| Current at max power | $I_{mp}$ | 5.69A |
| Open circuit voltage | $V_{oc}$ | 22.4V |
| Short circuit current | $I_{sc}$ | 6.03A |
| No. of series cell | $N_s$ | 36 |
| No. of parallel cell | $N_p$ | 1 |

$$I(V) = \frac{I_x}{1-e^{\left(\frac{-1}{b}\right)}}\left[1 - e^{\left(\frac{V}{bV_x}-\frac{1}{b}\right)}\right]$$

(3.1)

$$V_X = S\frac{E_i}{E_{iN}}TC_V(T-T_N) + sV_{max} - s(V_{max} - VmineEiEiM\ln Vmax-VOCVmax-Vmin$$

(3.2)

$$I_X = P\frac{E_i}{E_{iN}}[I_{SC} + TC_i(T-T_N)]$$

(3.3)

An interconnected dc-dc converter having PV cluster as source and an induction motor connected as the end as load is demonstrated in Figure 2.4.

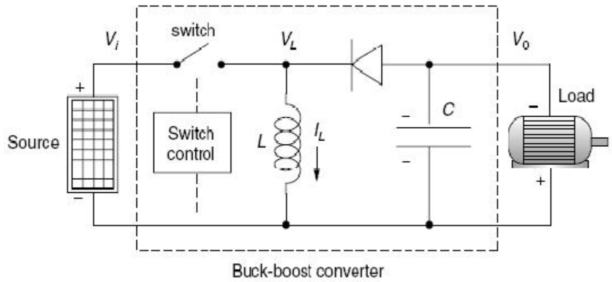


**Fig 3.4 Buck- Boost converter used as a maximum Power Tracker**

Since the yield voltage is higher than the info voltage, it is known as a lift converter. It is actualized by utilizing a diode and a MOSFET. In the lift converter the normal yield current is less than the normal inductor current. what's more, an a lot higher rms current would course through the channel capacitor because of this reason an enormous estimation of the inductor and channel capacitor is required than those of buck converter. [16]

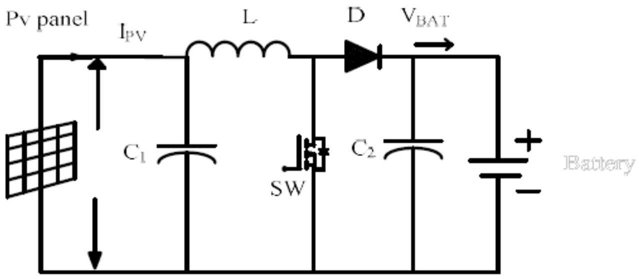


**Fig. 3.5 Boost dc-dc Converter topology used as photovoltaic power interface**

Here is a series connection between the output of the DC-DC converter and the photovoltaic panel to obtain high efficiency. Each panel is connected in series to a DC-DC converter. Switch The frequency of the converter ($F_{sw}$) is 50 kHz, and the output current ripple ($\Delta i_l$) and voltage ripple ($\Delta v$) they are considered 10% and 5% respectively. When the semiconductor is directing, the diode is in open circuit (Ton). Utilizing Equation (3,5), the value of the inductor is generated and calculated as discussed in following Equation. [15]

$$V_L = \frac{L\Delta L_L}{\Delta t} \tag{3.4}$$

Assuming $V_d$,$R_{Ly}V_{DS}$ are very small values;

$$\Delta I_l(+) = \frac{(V_s - V_o)}{L} T_{on} \tag{3.5}$$

$$\Delta I_L(-) = \frac{V_o}{L} T_{off} \tag{3.6}$$

In this research work, a charge controller with a boost configuration and a duty cycle controlled by a soft-computing-based controller is based on an improved fuzzy logic. The fuzzy controller is programmed to be able to operate in variable radiation Under illuminance and complex operating conditions, effectively and use the IV characteristics of the photovoltaic system to track the maximum power point. Stability has been simulated. The charge controller is connected to the output of the PV module, and the output of the charge controller is connected to the battery in storage applications and to the inverter in high-power applications. Therefore, according to aspects of this research, a high-efficiency power converter equipped with a soft computing-based MPPT controller system is used to improve the operating efficiency of the solar photovoltaic system. Through the implementation of an efficient charge controller based on the intelligent MPPT control system, the operating efficiency of the solar photovoltaic system is improved. There are many ways to track the maximum power point. Perturbation and Observation algorithm(P&O) is a basic computational technique for calculation of MPPT. The implementation of this algorithm is easy and less complex, so it is easy to apply. The output of this process algorithm is not very precise in case of rapidly changing climating conditions and multiple peak in characteristics of power vs voltage. However, this technology ensures that rapid modification of radiation levels (which can cause changes in MPPT) are not taken into account, and it is expressed as changes in MPP due to interference and incorrect MPP calculations. To avoid this difficulty, we can use the incremental conduction method. In the incremental conductance method, two current sensors and two voltage sensors are used to sense the output current and voltage of the PV array.

$$\left(\frac{dP}{dV}\right) MPP = \frac{d(VI)}{dV} \tag{3.7}$$

$$0 = I + \frac{VdI}{dV} MPP \tag{3.8}$$

$$\frac{dI}{dVMPP} = -\frac{I}{V} \tag{3.9}$$

Now, it is evident that the system can identify current and voltage at the maximum power point by calculating conductance with respect to power variation of the system. But the uncertainty caused by the change in irradiance was eliminated. Fuzzy Logic has been utilized for tracking the Maximum Power Point (MPP) of PV module since it has the upsides of being accurate, aggressive in tracking power point, moderately easy to plan and doesn't require the information on PV precise model. Fuzzy rationale control by and large comprises of three fundamental components: fuzzification module, fuzzy induction system, and defuzzification module. [14]The fuzzy logic system with improved rule base and membership function parameters can perform power tracking immediately, avoiding the problems of early convergence and stable response of power point tracking under given temperature and irradiation conditions. The purpose is to take care of the optimal duty cycle of the proposed system under given irradiance and temperature conditions. Figure 4.4 shows the curve of tracking power versus simulation time. It can be seen from the figure that the application of this method improves the tracking power and stability of the system.

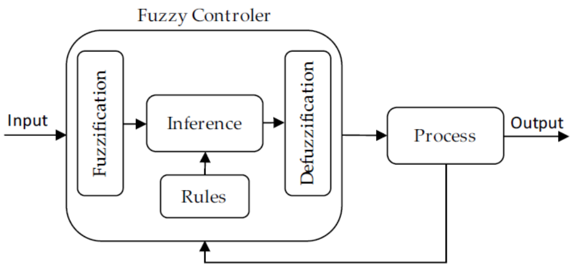


**Fig-3.6- Building Blocks of Fuzzy Based System**

During fuzzification, numerical information factors are changed over into semantic variable dependent on a weight and value. For MPPT, the genuine voltage and current of PV module estimated consistently is determined for obtaining the power as $P=V_{xI}$:[14]

$$E(k)\frac{P(k)-P(k-1)}{V(k)-V(k-1)} \quad (3.10)$$

$$CE(k) = E(k) - E(k-1) \quad (3.11)$$

Fuzzy control is a strategy that permits the development of nonlinear regulators from heuristic data that originates from the information on a specialist. The fuzzification plot is answerable for preparing the information and arrangement of rules to permit a sequential portrayal of the factors to be controlled and is in view of the information on the procedure. . [15]Membership function is decided to interrelate the input to output with a trapezoidal or centroid approach. This membership functions assign fuzzy rules and assign values as per the input parameters and scenario. Table 2 shows the 25 fuzzy standards applied in the regulator. The lines and sections speak to the two information sources E and ΔE. The output ΔD is a variable related at the crossing point of a line with a maximum power point.

**Table 2 Fuzzy Associative Matrix**

| E/ΔE | Very Low | Low | Neutral | High | Very High |
|---|---|---|---|---|---|
| Very Low | VH | VH | H | VL | VL |
| Low | H | H | H | VL | L |
| Neutral | H | H | N | L | L |
| High | H | H | L | L | VL |
| Very high | H | H | L | L | VL |

The centre point (ΔD) is processed by,

$$\Delta D = \frac{\sum_{j-1}^{n} \mu(\Delta D_l)\Delta D_i}{\sum_{j-1}^{n} \mu(\Delta D_j)} \quad (3.12)$$

$$D(k) = D(k-1) + S_{\Delta D}\Delta D(k) \quad (3.13)$$

Two calculations; Center of Area (COA) and the Max Rule Method (MCM) can perform defuzzification ordinarily.

## IV. CONCLUSIONS

In this review and analysis work a charge controller having boost configuration and duty cycle controlled by soft computing based controller which is based on improved fuzzy logic which is programmed to track maximum power point from I-V characteristics of PV system under variable irradiance and complex operating condition efficiently and with stability has been discussed. The charge controller is connected to the output of PV modules and the output of charge controller is connected to battery under storage applications and to the inverter under high power applications. Thus according to the aspects of present research it is provided with the with the enhancement of operating efficiency of solar photovoltaic system using efficient power converter equipped with soft computing based MPPT controller system. It improves the operating efficiency of solar photovoltaic system by implementation of efficient charge controller based on intelligent maximum power point tracking control system.Charge controller can be interfaced with the battery for storage applications of solar photovoltaic system and with the inverter system for high power applications.

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