iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 4 **Issue:** XII **Month of publication:** December 2016

DOI:

International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Selective Harmonic Elimination for Solar Cell based Multi-Level Inverter System Using Moth Flame Optimization

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Abstract— Themulti level inverter is powerful electronic device, which is widely used for high power utility application. The main purpose of the multi-level inverter is to provide sinusoidal wave from with low-level harmonic content to reduce distortion. For improvement of the quality of multilevel inverter output voltage it is required to reduce the harmonic level. The fully controlled bridge is used in multilevel inverter. The switching angles of the IGBT/MOSFET need to be controlled in specific pattern to eliminate the particular harmonic. The analytical calculation is possible to find the set of solution (switching angles) for harmonic elimination. As the levels of the inverter increases, the analytical method becomes complex and difficult. The use of the evolutionary algorithm becomes popular for identifying the optimum value of angles. In this paper, 5 level cascaded bridge inverter taken for selective harmonic elimination. For identifying the switching angle moth flame optimization technique is used.
Keywords—SHE, Inverter, MFO, evolutionary algorithm, Optimization, Solar cell, etc.

I. INTRODUCTION

Photo voltaic sources are used today in many applications as they have the advantages of being maintenance and pollution free. The solar fed cascaded multilevel inverter produces AC output voltage of desired magnitude and frequency. The output waveform of the inverter can be improved by reducing its respective harmonic content. Since the inverter is used in a photovoltaic technique, a optimization technique is used to obtain the switching angles to reduce the harmonic content.

II. RELATED WORK

The many researchers have been done significant work in the field of Selective Harmonic Elimination Technique Based different optimization Techniques problem some of the work is described in this paper.
ZHANG Wenyi, et.al, [1], done study in this paper, Selective Harmonic Elimination Technique based on Genetic Algorithm (GA), which can be arbitrary for the choice of initial value, make up for the deficiency of the Newton iterative algorithm, there is no need predict the tendency of switch angles in the entire modulation range in advance. Load can be better inhibition for selective harmonic elimination method based on GA, the size of the load will affect the output waveform of the inverter, and cause the increased harmonic content. Increasing the number of switching angle can reduce the harmonic content of the output current and total harmonic distortion. In this paper study of three-phase asynchronous motor, once again confirms the significance of genetic algorithm in the practical application.
T.JEEVABHARATHI, et.al, [2], investigate in this paper, elimination of harmonics in a Cascaded Multilevel Inverter technique by considering the non-equality of separated dc sources by using PSO is presented. The solving a nonlinear transcendental equation set describing the harmonic elimination problem with non-equal dc sources reaches the limitation of contemporary computer algebra software using the resultant method. In this paper using PSO optimization technique has been proposed to solve the Selective Harmonic Elimination problem with non-equal dc sources in H-bridge cascaded multilevel inverters. Approach reaches the limitation of contemporary algebra software tools, method is able to find the optimum switching angles in a simple manner.

III. MULTILEVEL INVERTER

Multilevel inverters generate a stair case wave form. By increasing the number of output levels, the output voltages have more steps and harmonic content on the output voltage system and the THD values are reduced. Produce high quality output voltage by increasing the number of levels. In Cascaded H-Bridge Multi Level Inverter topology, H-bridges inverter are cascade in every phase. With the increase in H-bridges in a phase, the output voltage waveform tends to be more sinusoidal. In n-level topology (n-1)/2identical DC bus of every individual H-bridge system. Hence, this topology is useful for collecting energy from renewable

Volume 4 Issue XII, December 2016
ISSN: 2321-9653
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energy resources e.g., solar panels and fuel cell. Cascaded H-bridge inverter topology offers better performance compared to other topologies. This high resolution multilevel waveforms can be achieved relatively low number of components. These waveforms can be achieved with relatively low number of components

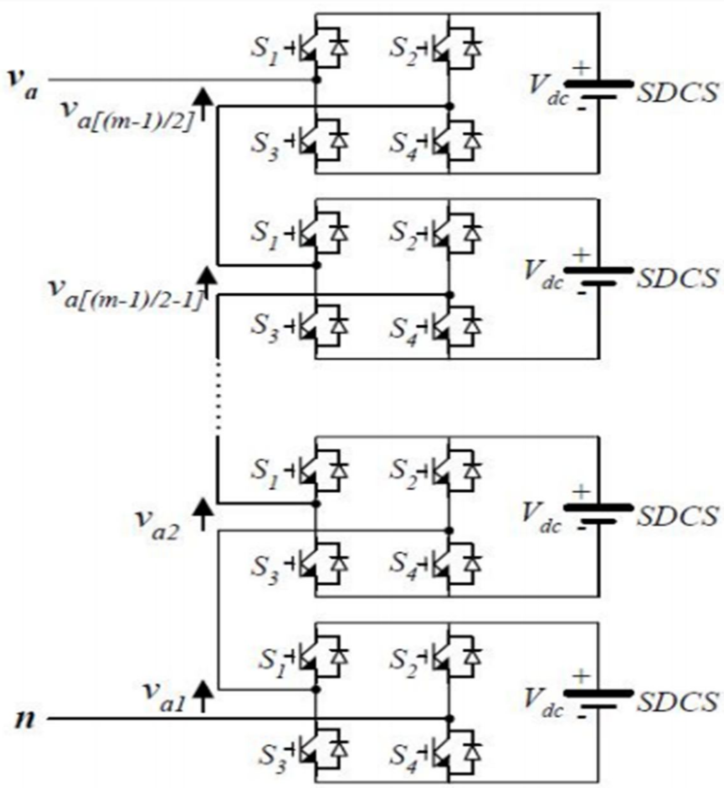

Fig. 1 Circuit Diagram of Multi-Level Inverter

IV. SOLAR PHOTOVOLTAIC OVERVIEW

Photovoltaic cells look similar to solar panels but they work in a different way flow. Solar panels are use to produce hot water or even steam. The photovoltaic panels convert the sunlight directly into electricity. This type of device only needs a small amount of electrical power to work and can even be used in a room with artificial light Although we see photovoltaic cells powering small devices such as calculators they have a more practical application especially in the third world. A typical example of a device powered by photovoltaic cells is a solar powered calculator. Photovoltaic cells have been developed that will provide electrical power to pump drinking water from wells in remote villages. During the day the cells power the phone and also charge batteries. For the batteries power the phone during the night. In often photovoltaic cells are used as a backup to conventional energy. Its conventional fails the cells are used to produce electricity

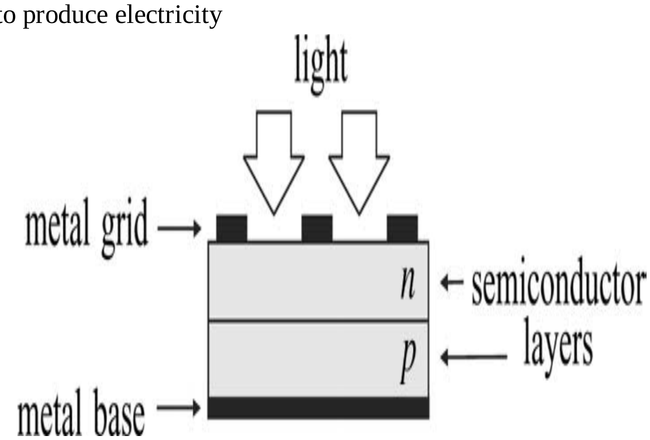

Fig1.Physical structure of a PV cell

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ISSN: 2321-9653
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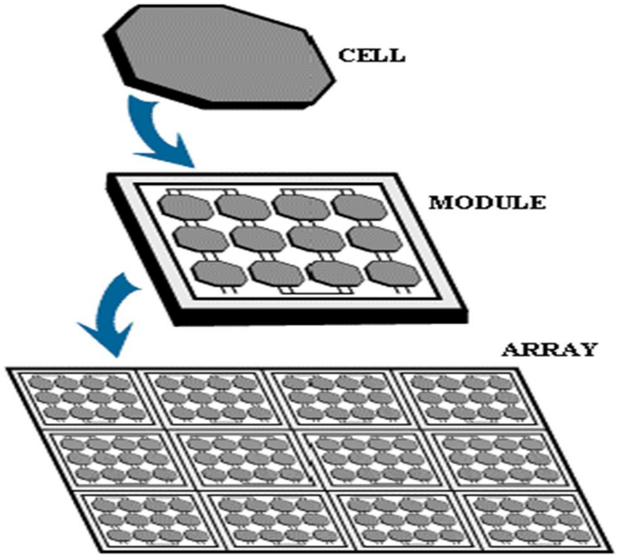

Fig.2 Cell with array

A number of solar cells electrically connected to each other and mounted in a support structure or frame is called a photovoltaic module. The modules are designed to supply electricity at a certain voltage calculation, such as a common 12 volts. The current produced is directly dependent on how much light strikes the module

V. MOTH FLAME OPTIMIZATION

In the proposed MFO algorithm, I assumed that the candidate solutions are moths and the problem's variables are the position of moths in the space. Therefore, the moths can fly in 1-D, 2-D, 3-D, or hyper dimensional space with changing their position vectors. Since the MFO algorithm is a population-based algorithm.

It should be noted here that moths and flames are both solutions. The difference amongthem is the way we treat and update them in each iteration. The moths are actual search agents that move around the search space, whereas flames are the best position of moths that obtains so far. Other words, flames can be considered as flags or pins that are dropped by moths when searching the search space. Therefore, each moth searches around a flag (flame) and updates it in case of finding a better solution. With this mechanism, a moth never lose its best solution.

I chose a logarithmic spiral as the main update mechanism of moths in this paper. Types of spiral can be utilized here subject to the following conditions:

A. Spiral's initial point should start from the moth
B. Spiral's final point should be the position of the flame
C. Fluctuation of the range of spiral should not exceed from the search space

Considering these points, I defined a logarithmic spiral for the MFO algorithm as follows:

$$S(M_i F_i) = D_i . e^{bt} . \cos(2\pi t) + F_j \qquad (1)$$

Where Di indicates the distance of the i-th moth for the j-th flame, b is a constant for defining the shape of the logarithmic spiral, and t is a random number in [-1,1].

D is calculated as follows:

$$D_i = |F_j - M_i|$$

With the above equations, the spiral flying path of moths is simulated. As may be seen in this equation, the next position of a moth is defined with respect to a flame technique. The t parameter in the spiral equation defines how much the next position of the moth should be close to the flame. Therefore, a hyper ellipse can be assumed around the flame in all directions and the next position of the moth would be within this space. Spiral movement is the main component of the proposed method since it dictates how the moths update their positions around flames. The spiral equation allows a moth to fly "around" a flame and not necessarily in the

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space between them. In exploration and exploitation of the search space can be guaranteed. The logarithmic spiral, space around the flame, and the position considering different t on the curve are illustrated as follows:

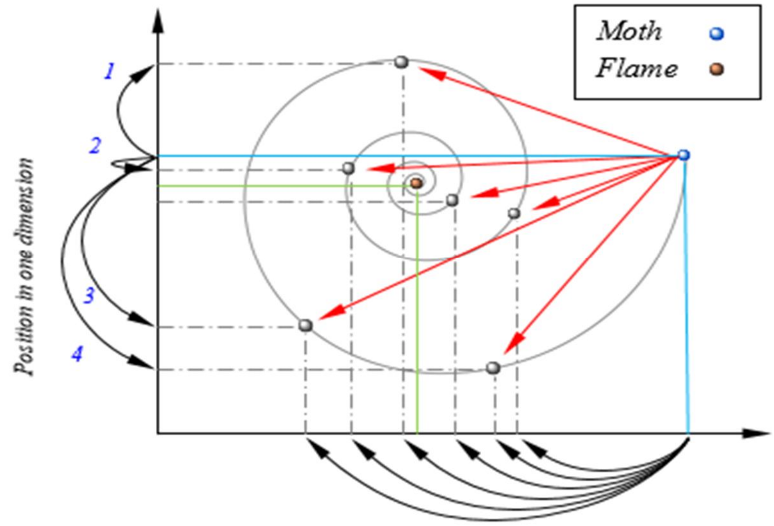

Fig. 4 Moth Flame Algorithm

That the vertical axis shows only one dimension (1 variable/parameter of a given problem), but the proposed method can be utilised for changing all the variables of the problem. Possible positions that can be chosen as the next position of the moth around the flame clearly show that a moth can explore and exploit the search space around the flame in one dimension. Exploration occurs when the next position is outside the space among the moth and flam as can be seen in the arrows labelled by 1, 3, and 4. Exploitation happens when the next position lies inside the space between the moth and flame as can be observed in the arrow labelled by 2.

VI. SIMULATION AND RESULTS

All simulation results of the proposed Selective Harmonic Elimination for Solar Cell based Multi Level Inverter System Using Moth Flame Optimization are done on MATLAB/Simulation.

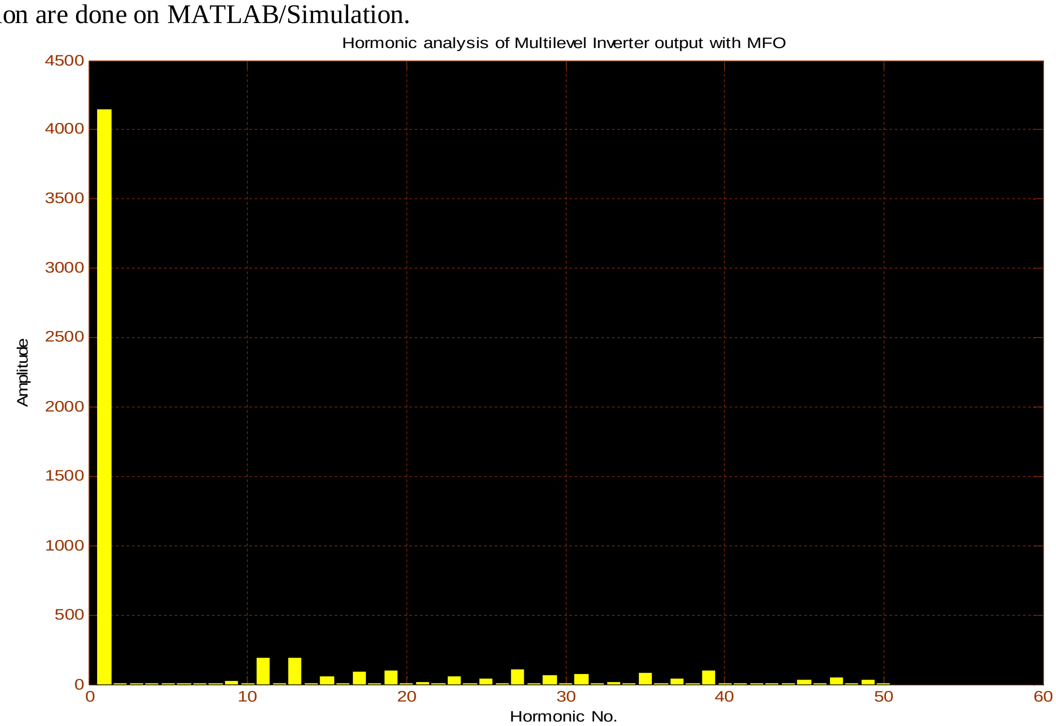

Fig.5 Performance of harmonics analysis multilevel inverter output with MFO

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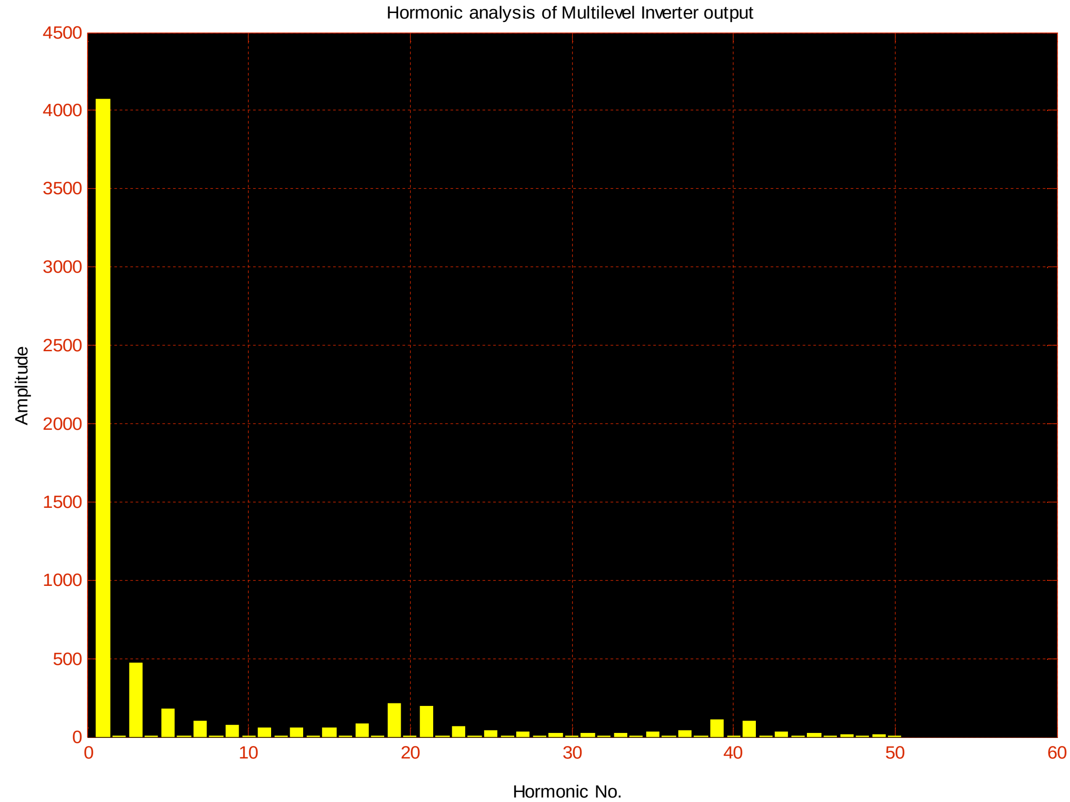

Fig. 6Performance of harmonics analysis multilevel inverter output without MFO

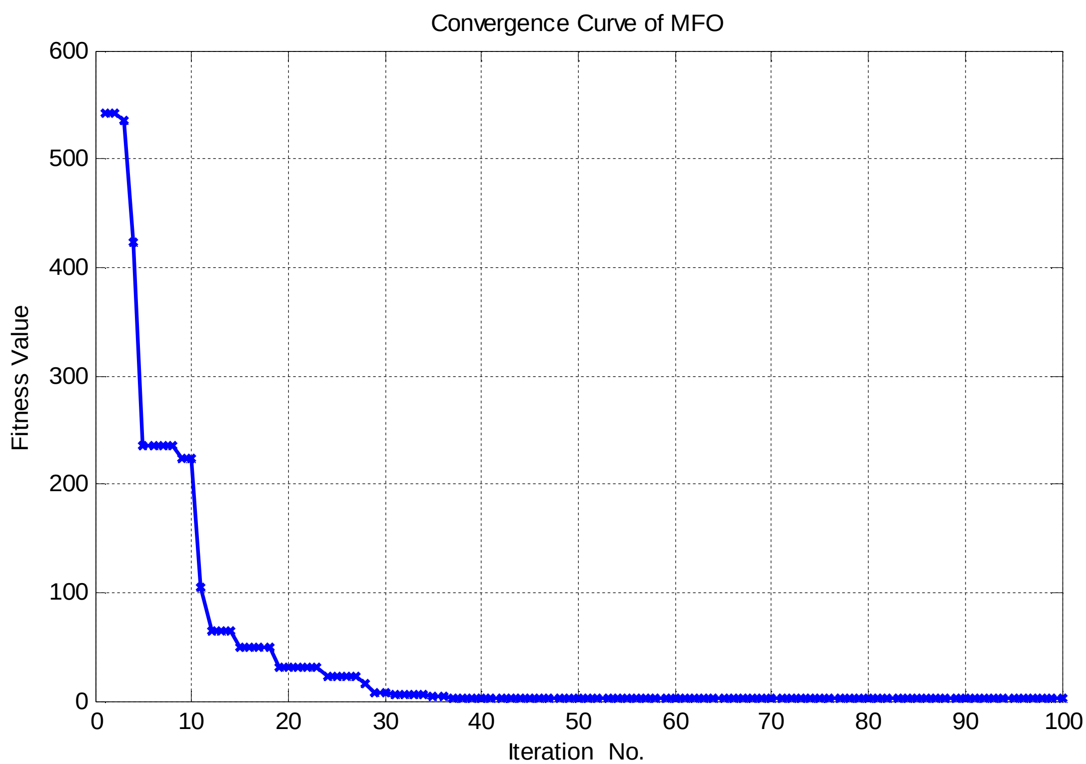

Fig. 7 Performance of harmonics analysis multilevel inverter convergence curve of MFO

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ISSN: 2321-9653

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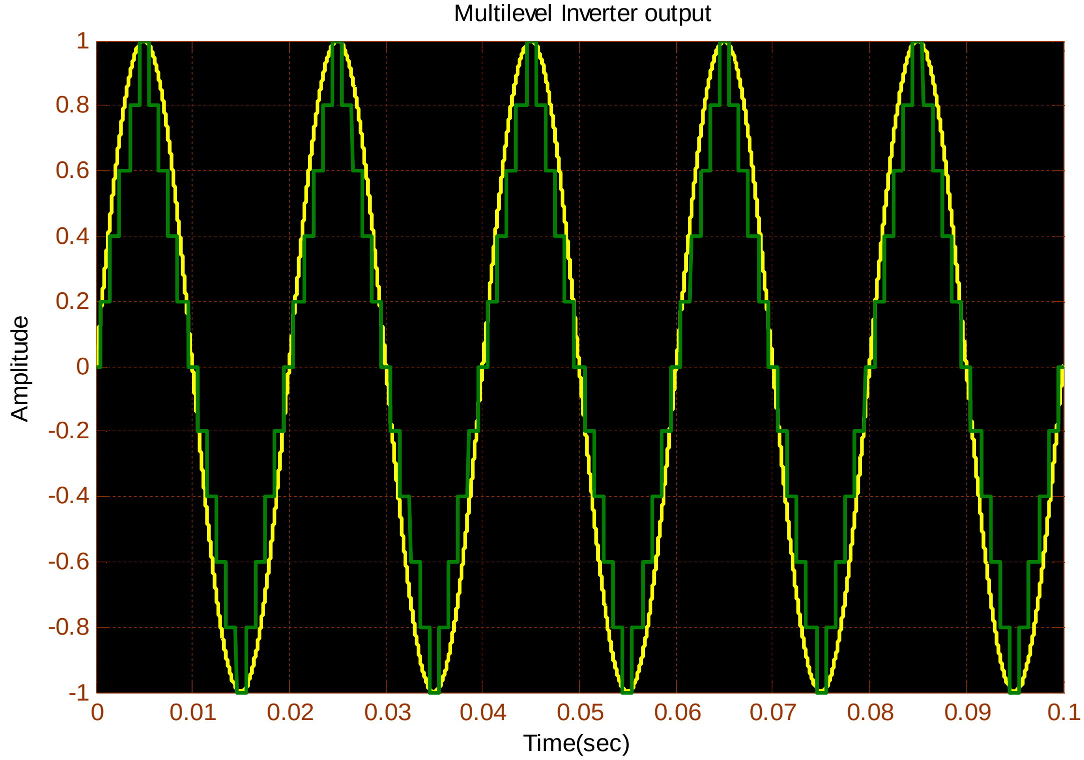

Fig. 8Performance of harmonics analysis multilevel inverter output time Vs amplitude

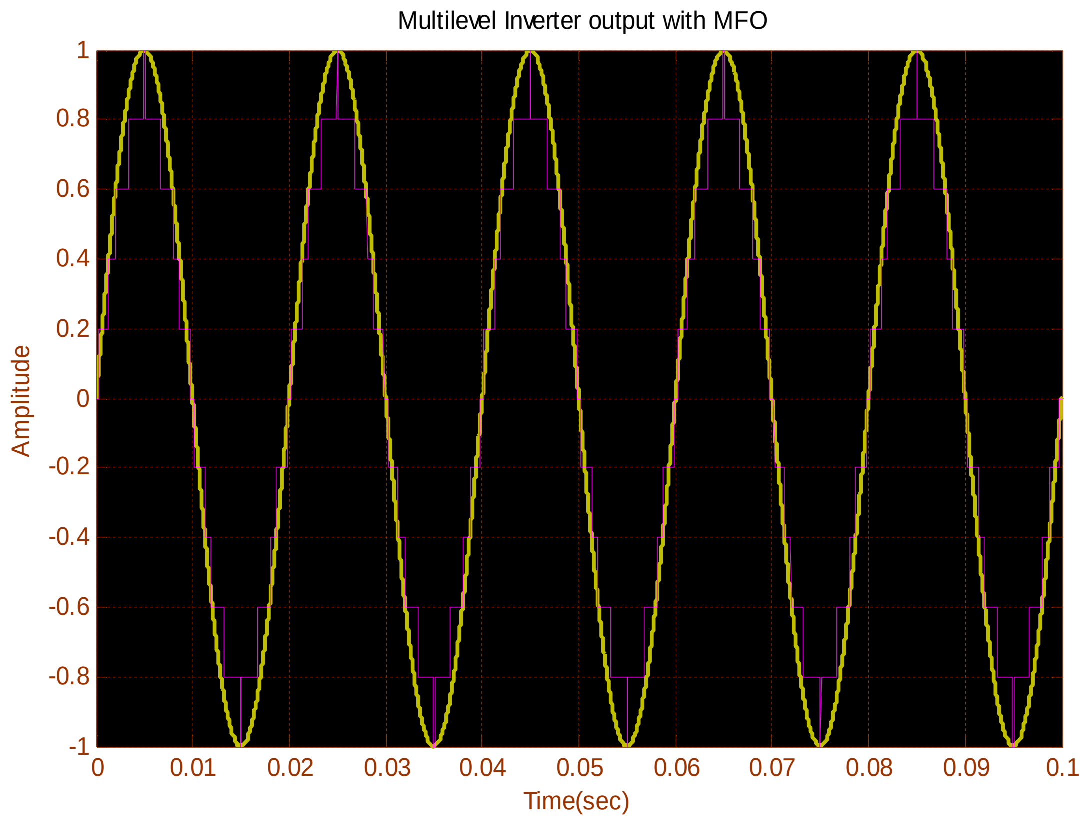

Fig. 9Performance of harmonics analysis multilevel inverter output with MFO time Vs amplitude

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VII. CONCLUSIONS

The performance of Selective Harmonic Elimination for Solar Cell based Multi-Level Inverter System Using Moth Flame Optimization. The multi-level inverter is powerful electronic device, which is widely used for high power utility application. The main purpose of the multi-level inverter is to provide sinusoidal wave from with low-level harmonic content to reduce distortion.From the comparison we identify that as level of the inverter is increases the Total Harmonic Distortion is decreases and the performance is improved. For analysis of this inverter SHE (Selective Harmonic Elimination) method can also be used to reduce harmonics. The simulation and experimental results are increasing the number of switching angle can reduce the harmonic content of the output current and total harmonic distortion.

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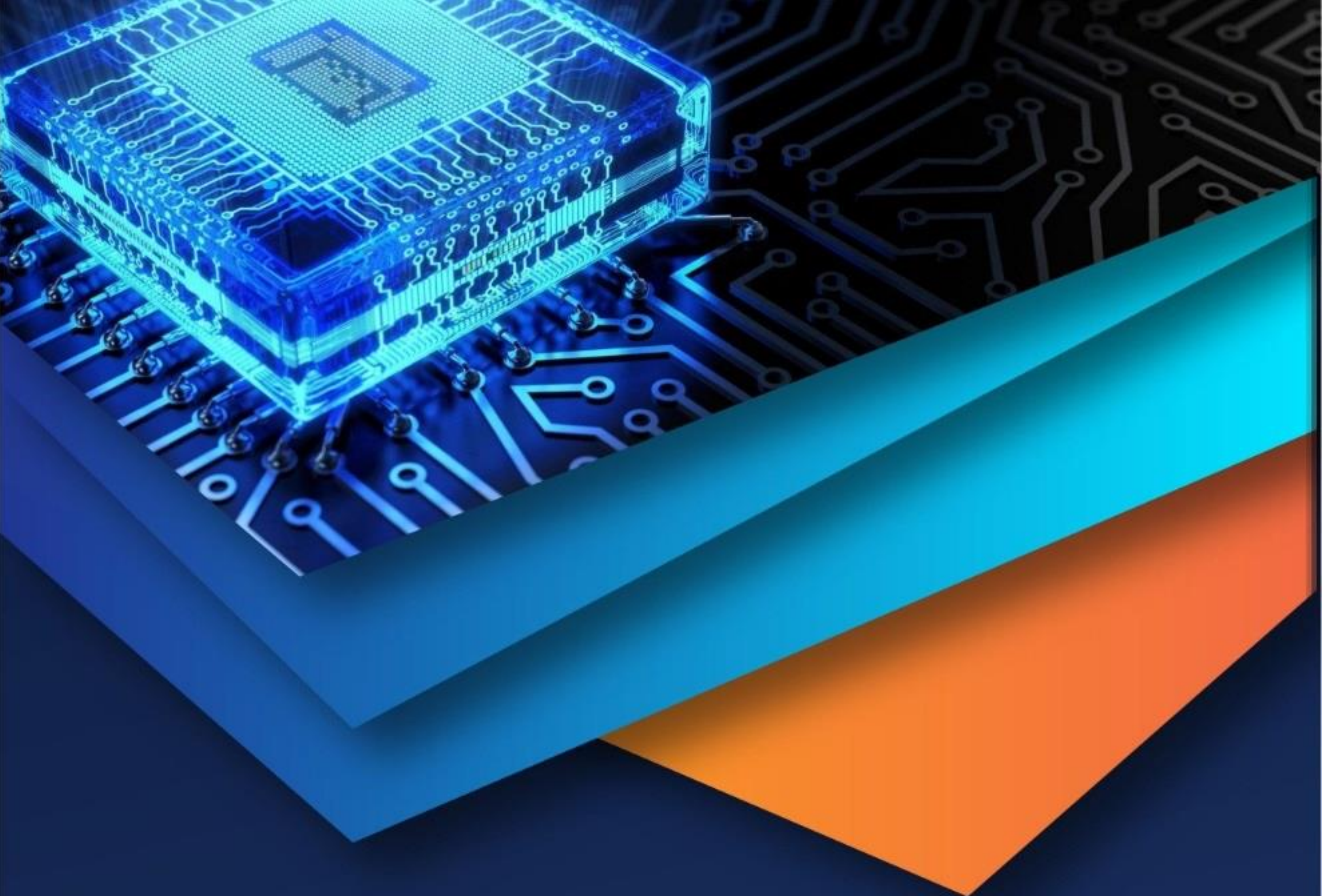

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