

## A NOVEL PROPOSAL IN MULTILEVEL INVERTER WITH GENETIC ALGORITHM OPTIMIZATION

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### **Abstract**

In transformation of resources like power the multilevel inverters are the best technology. Output as stair waveform signal feed as input to many of the DC sources. The description of multilevel inverter topology is described in the paper. The presentation consist of 7 level architecture principle and to obtain best quality of output signal the algorithm of adaptive genetic is adopted to slow down the harmonic content. In actual time the evaluations of appropriate switching angle used to analyse the THD minimization. The overall observations are declined based on 7 level to cases in other levels and THD determination in various states. These studies are based on MATLAB simulation and programming. The proposed work is simulated using MATLAB software which gives the model accuracy rate of 80% with the lesser error rate. The multilevel inverter designed using the proposed method removes the harmonic function at various input voltage with the minimum loss factors.

Keywords: multilevel inverters, THD minimization, adaptive genetic algorithm, harmonic function

### **I Introduction**

The most common method of DC/AC conversion is the multilevel inverters because of evolution of multilevel inverters (MLIs). The architecture concepts are proposed to form new techniques and conversion in MLIs [1]. The evaluation of MLIs with grid formation and control techniques has gives huge credits in development of distributed generation in renewable energy stations. The main objective in reduction of external regulation dependency has push forwarded in MLIs development. The most of the complementation's are consider for studies on reduction switching devices, capacitors and power diodes [2]. In classic inverters with optimization of output signal has harmonic elimination of pulse width modulation (PWM) which gives reliability and efficiency in terms of quality of power. In multilevel conversion field the MLIs has balancing charge state and enhanced architecture. By reduction in components and optimize the switching angles can improve power quality to maximum and minimum harmonics [3]. To enhance perfect optimization with special cases

by study of research commands on targeted optimized in inverter cells for power sharing. The above can be demonstrated by optimizing command patterns or elimination of selective harmonics [4-8]. In regular study of grid connected applications of MLIs using optimal switching cycle development by classic topologies hybrid multilevel architecture design and regulation and integrated filtering. With the various range of voltages MLIs can operate in both high and medium voltage applications [9-10].

In new enhanced MLIs topologies has efficiency and accuracy has high range of power distribution MLIs. The scope of the work is to maintain improper balancing of DC load even on stress power components. There various multilevel inverters such as the Cascaded H-bridge Multilevel Inverter (CHMLI), Flying Capacitors Multilevel Inverter (FCMLI) and the Diode Clamped Multilevel Inverter (DCMLI). Between the above topologies CHMLI has the better reliable architecture for varying the inverter levels and efficient characteristics [11-16]. As the improvement concern and upgrades and low harmonic distortion is achieved in CHMLI. These MLIs has characteristics of reduction of semiconductor switching components and has higher level operation. In nature of new MLIs has best signal quality and during voltage switching on less stress and low harmonic content. While usage of sensitive electronic gear and higher power applications has clear output signal throughout the process. The minimal reduction of appropriate multi objective transcendental functions achieved during THD reduction. The core objective of the proposed work is the reduction of THD in new MLIs. The algorithm of adequate genetic technique is used to find perfect correct switching angle on DC/AC signal conversion. The analysis of MLIS performance based on with and without adopting CHMLI for harmonic analysis [17].

## II.REMOVAL OF SELECTIVE HARMONICS

The technique undergone to eliminate the harmonics within the multilevel inverter is selective Harmonic eliminated the technique of PWM. This technique implies the derivation angle of switching which is represented as  $\theta_1, \theta_{2,3}, \dots, \theta_N$  so that the (N-1). The switching angles the fundamental voltage of the system can be controlled. The waveform of the proposed system is derived from the fourier series which is represented in the form of quarter wave symmetric waveform. The equation is derived as follows

$$V_{out}(\omega t) = \frac{4V_{dc}}{n\pi} \text{ where } n=1 \quad (1)$$

$s = \cos n\theta_k \sin n\omega t$  where  $k=1$

$\theta_k$  represents the switching angles which consist of following conditions.

1.  $\theta_1, \theta_{2,3}, \dots, \theta_s < \pi/2$  where  $s$  indicates the quantity of H-bridge cells and  $n$  represents the odd order of the harmonic function,  $V$  represents the amplitude of the input dc voltage.

The component function within the removal of harmonic is represented as the below condition

· The dc component amplitude tends to be zero

· The fundamental amplitude off odd value within the function is represented as the

$$h_1 = 4V_{dc}\pi s \text{ k}=1, \cos(\theta_k) \quad (2)$$

$$h_n = 4V_{dc} n \pi s k = 1, \cos(n\theta_k) \quad (3)$$

· The amplitude of all even harmonics equals zero.

The waveform which is represented as quarter-wave symmetric multilevel waveform has the odd harmonic function as the input factor. The major reason for obtaining the low voltage output is carried out using switching angles. The total harmonics distortion (THD) calculated using the following equations

$$THD = \sqrt{\sum h_n^2} / h_1 \quad (4)$$

The fundamental amplitude as well as the lower order harmonics can be controlled using the non-linear equations of transcendental model. Initial processing starts with the findings in the switching angles such as  $\theta_1, \theta_2, \theta_3, \dots, \theta_s$  where  $s=5$ . The switching angles are calculated using the above equation to eject the low-level order harmonics. The angle of switching has determined from the separate modulation index which reduces the harmonic rate as well as the distortion rate. This distortion rate cannot affect the output voltage as it tends to have the low switching angles. The eliminate of distortion is done using the following equations

$$\cos \theta_1 + \cos \theta_2 + \cos \theta_3 + \cos \theta_4 + \cos \theta_5 = 3\pi M / 4 \quad (5)$$

$$\cos 5\theta_1 + \cos 5\theta_2 + \cos 5\theta_3 + \cos 5\theta_4 + \cos 5\theta_5 = 0 \quad (6)$$

$$\cos 7\theta_1 + \cos 7\theta_2 + \cos 7\theta_3 + \cos 7\theta_4 + \cos 7\theta_5 = 0 \quad (7)$$

$$\cos 11\theta_1 + \cos 11\theta_2 + \cos 11\theta_3 + \cos 11\theta_4 + \cos 11\theta_5 = 0 \quad (8)$$

$$\cos 13\theta_1 + \cos 13\theta_2 + \cos 13\theta_3 + \cos 13\theta_4 + \cos 13\theta_5 = 0 \quad (9)$$

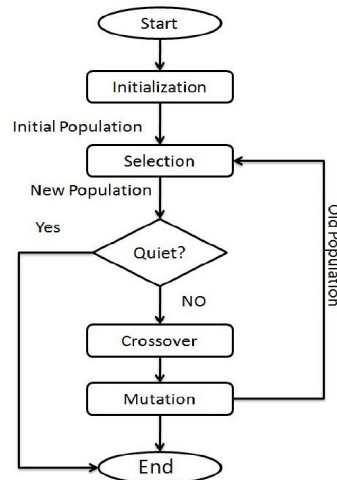
The equation to derive the modulation index of the multilevel inverter is obtained as

$$M = h_1 s V \quad (10)$$

Thus, the modulation index ranges from 0 to 1 where the distortion reduces with the PWM technique.

### III. GENETIC ALGORITHM

Genetic algorithm is one of the best quality improvement techniques that resolve the best individual findings using the genetic process. The process involves the various procedures such as reproduction, crossover, and mutation. Various applications involve the genetic algorithm that implements the reduction in the optimized values. To reduce the harmonic error is carried out using PWM-SHE technique. The technique used to reduce the optimal value is the global optimal solution within the implemented system. Iteration of Genetic Algorithm is carried out using the various set of strings which is known as chromosomes. These chromosomes are analyzed using the genetic operations with the improved fitness function [18].



**Figure 2.1 Genetic Algorithm**

### 3.1 Chromosome Representation

In the Genetic Algorithm, the core objective of the proposed algorithm includes the one dimensional arrays with the S is an length where S represents the number of angles within the system.

### 3.2 Initialize Population

Initial stage of processing starts with setting the population count and number of chromosome. The chromosome value set randomly. The range of the genes starts as the initial population. The population size and the value depends upon the various problem and the performance balance occurs between the complexity in time and measurement in space within the model.

### 3.3 Reproduction

Reproduction process is carried out using the parents chosen during the genetic algorithm. The parents chosen create the offspring and processing initiates with the processed chromosome. These chromosomes are selected from the copied objective function. Each objective function is characterized by the degree of conformity and they can be reformed using the flat rule based on the algorithm proposed.

### 3.4 Crossover

Crossover is the major processing stage in the genetic algorithm which analyzes the parental and offspring. The gang of children are created using the parent gene. This analyzed parent gene is exchanged to form new child. The newly formed offspring consists of mixture of both parents. The crossover doesn't form new offspring alone; it also provides the testing inside the chromosome. The chromosome is represented inside the population structure is allowed for the parameter optimization.

### 3.5 Mutation

Mutation is the next stage towards the genetic optimization. In the mentioned process, the probability of the analyzed gene is calculated and become mutated. This mutated gene is copied from parents towards offspring. The process is repeated with the regular iteration until the core functionality is achieved.

### 3.6 Evaluation of fitness function

The main processing unit of the proposed work is to analyze the reliability function of every

chromosome with the minimal expense function. The implementation is carried out to minimize the harmonics; fitness function is related towards the THD. In the proposed work 5<sup>th</sup>, 7<sup>th</sup>, 11<sup>th</sup>, and 13<sup>th</sup> harmonics at output of an eleven-level inverter are to be minimized.

For every chromosome, the proposed multilevel inverter has the minimum output voltage. The waveform for the output voltage is represented as formation of stepped layer with the variation in the switching angles in the chromosome. The removal of harmonics initialize with the magnitude calculation of harmonics [19].FFT technique is used to remove the harmonic function with the various numbers of iterations. Genetic Algorithm is carried out with the certain number of iterations to get the optimal value. After the initial iteration, FV's is used to analyze the offspring with the chromosome. Then the process undergoes with the mutation as well as the crossover technique and again another new population is carried out at the end of the iteration. The table 1 represents the switching angle variation with the optimized value.

**Table 1 Initial switching angle as well as modulation index**

Modulation Index (M)	Switching Angles			
$\theta_1$ (radian)	$\theta_2$ (radian)	$\theta_3$ (radian)	$\theta_4$ (radian)	$\theta_5$ (radian)
0.1	0.525	0.859	0.997	1.274
0.2	0.20	0.5	0.99	1.568
0.3	0.194	0.46	0.793	1.117
0.4	0.094	0.609	0.774	1.367
0.5	0.091	0.605	0.774	1.374
0.6	0.312	0.666	0.954	1.169
0.7	0.082	0.354	0.49	0.95
0.8	0.628	0.89	1.133	1.48
0.9	0.09	0.589	0.781	1.382
1.0	0.292	0.64	1.107	1.563

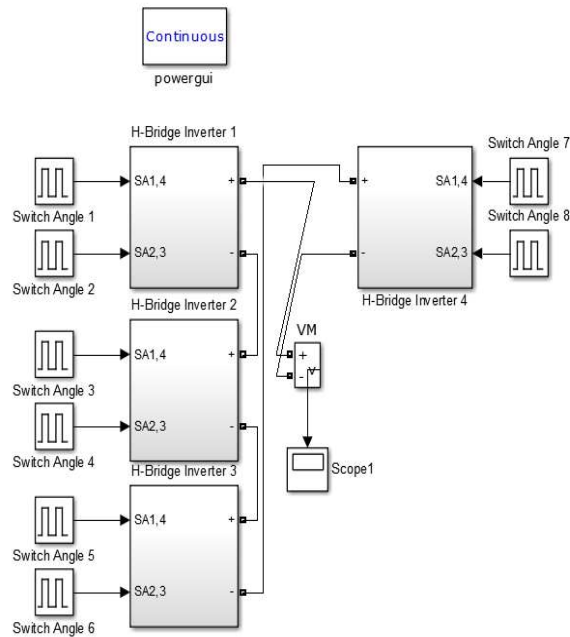
Initial switching and modulation index of the proposed model is shown in the table 1. By changing the switching angle, the modulation index change.

**IV. EXPERIMENTAL RESULTS**

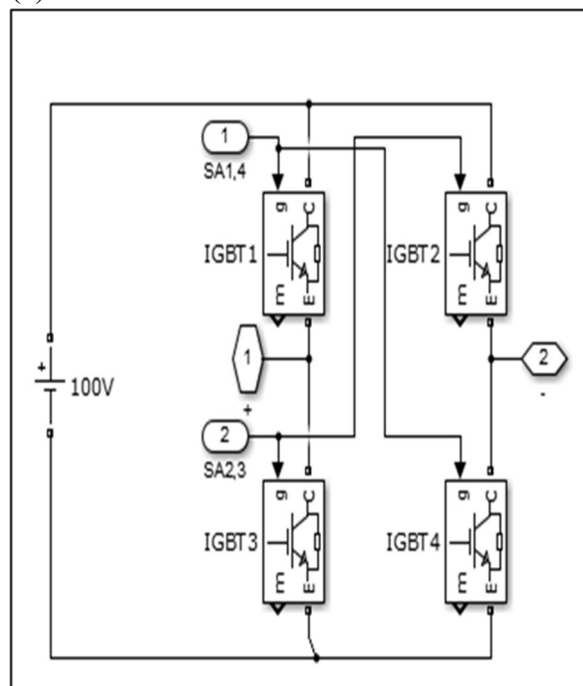
**4.1 Simulation of the multilevel inverter**

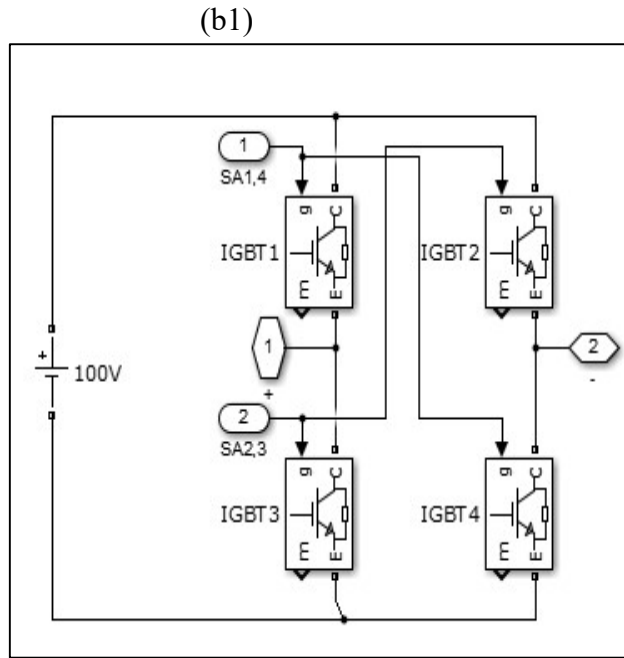
The experimental analysis was done by the simulink model using Matlab [20]. The simulink template designed using the multilevel inverter is the named as new MLI. Initial values of the switches give the calculated results of the genetic algorithm. The model designed in the Matlab is shown in the figure. It adapts the various levels of Multilevel Inverter. There are nine multilevel inverters with the eight switches within the model. The pulse waveform is generated using the principal switches S1, S2,.....S8. The stepped waves produced by these switches for every half cycle. Inverse switching is

carried out which is analyzed as the H bridge structure. Inverting the signal for every half cycle doesn't affect the configuration, and also their command also doesn't change. The switching process is carried out using the Genetic Algorithm. The input voltage is from the different pulses which generates the certain output signal with the lesser voltage. The harmonic function can be eliminated with the generated MLI that is compared with the AC signal. Comparison between the other inverter and newly formed MLIs has semiconductor components of optimal values.



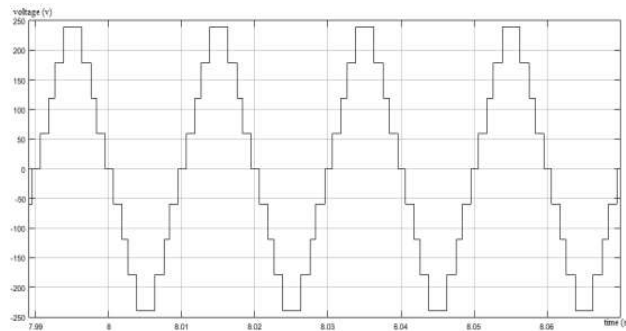
(a)





(b2)

**Figure 4.1(a) Matab simulation of the proposed MLI model (b1),(b2) Hybrid model for multilevel inverter**



**Figure.4.2 output waveform of the multilevel inverter with 8<sup>th</sup> switches**

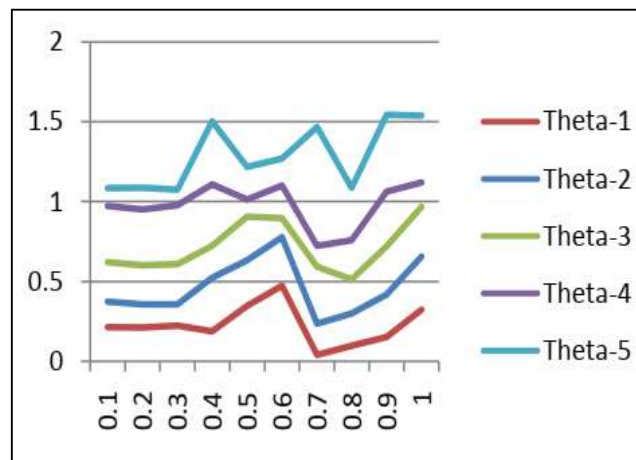
**Table 2 results given by single set the genetic algorithm on single test**

<i>N''</i>	<i>H1</i>	<i>H2</i>	<i>H3</i>	$\Theta 1$	$\Theta 2$	$\Theta 3$	$\Theta 4$	<i>THD (%)</i>	<i>M</i>
1	2.742	0.609	0.002	0.223	0.686	0.982	2.360	22.92	0.40
2	2.644	0.002	2.673	0.072	0.784	0.898	2.672	22.77	0.44
3	2.644	0.002	2.673	0.072	0.784	0.898	2.672	22.77	0.44
4	2.229	0.222	0.243	0.262	0.662	0.829	2.279	26.24	0.36
5	2.244	0.024	0.002	0.268	0.643	0.790	2.279	24.26	0.36
6	2.269	0.437	0.002	0.272	0.786	2.278	2.670	22.03	0.49
7	2.693	0.003	2.308	0.299	0.769	0.927	2.499	22.02	0.43

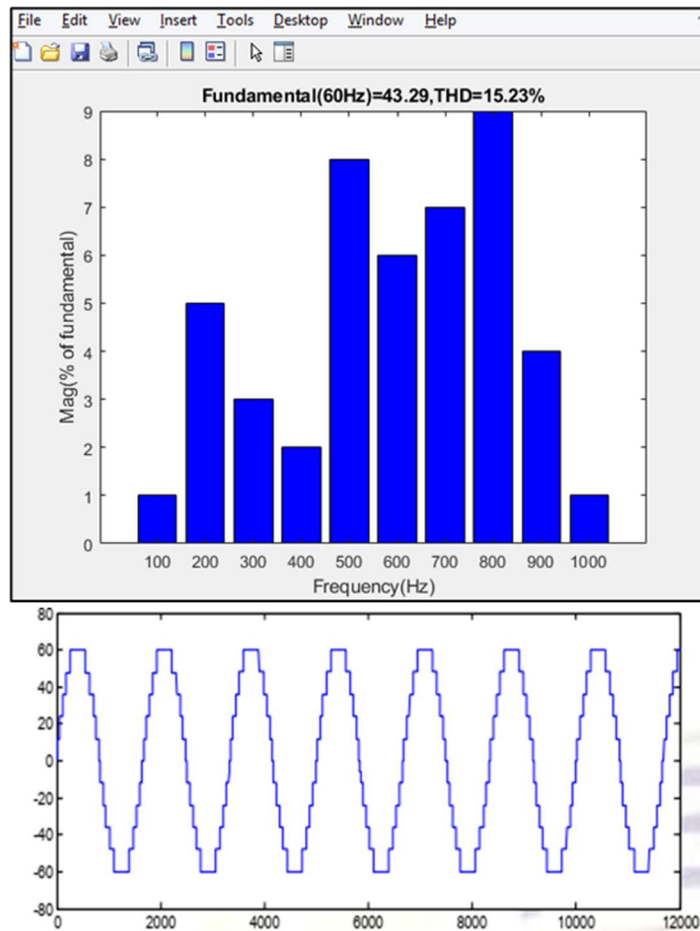
8	2.466	0.228	0.349	0.247	0.729	2.067	2.626	20.26	0.46
9	2.466	0.006	2.462	0.222	0.783	0.990	2.662	20.72	0.46
10	2.637	0.066	0.678	0.238	0.734	0.993	2.608	20.86	0.44
11	2.643	0.003	2.676	0.074	0.786	0.898	2.672	22.77	0.44
12	2.842	0.270	0.008	0.262	0.606	0.879	2.390	26.62	0.39
13	2.336	0.274	0.487	0.267	0.786	2.208	2.668	22.79	0.48
14	2.399	0.028	0.877	0.270	0.786	2.040	2.663	22.70	0.46
15	2.666	0.382	0.046	0.230	0.696	0.984	2.423	22.02	0.42
16	2.386	0.060	0.832	0.270	0.786	2.062	2.667	22.79	0.47
17	2.860	0.207	0.426	0.238	0.664	0.836	2.373	28.47	0.39
18	2.268	0.432	0.004	0.272	0.786	2.278	2.672	22.03	0.49

**Figure 4.3 Output signal of the multilevel inverter with the switching angle**

By the variation in the switching angle with the genetic algorithm optimization results is in the figure below. The cascaded multilevel inverter with the 5<sup>th</sup>, 7<sup>th</sup>, 11<sup>th</sup> harmonics have the lesser magnitude function. The fundamental component reduces with the elimination of harmonic function. By the variation in the switching angle with the modulation index using the Genetic Algorithm is shown.



**Figure 4.4 Switching angles against modulation index**



**Figure 4.5 Response of the multilevel inverter**

## V. CONCLUSION

In the study of multilevel inverter architecture conclude the technique on controlling and reduction in usage of quantity of semiconductor components. We justify the efficiency between multilevel inverter in cascaded H-bridge and the newly formed THD multilevel inverter is highly reliable and efficient than other nearly in the range of configuration from 3 to 15 in comparison test. On switching DC to AC in order to optimize the THD multilevel inverter genetic algorithm is implemented. For simulation 9 levels of mode has taken for observation. Even in 3<sup>rd</sup> and 7<sup>th</sup> harmonics is good to control the harmonic content while using the applied genetic algorithm. This algorithm is gives result in favour of accuracy. In actual time the newly formed multilevel inverter with genetic algorithm has predetermination nature since it easy to consolidate the causes by load on harmonic content. The output of new multilevel inverter has ability of higher in purification of signals in required limits. As an outlook of study is to determine prototype based model of inverter about the usage of genetic algorithm and optimized methods in the new multilevel inverter.

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