POWER QUALITY IMPROVEMENT IN PV GRID CONNECTED SYSTEM USING MULTILEVEL CONVERTERS WITH REDUCED NO. OF SWITCHES

P.SURESH[1],S.JAGADEESH[2], P.SUNIL[3], S.SOWSHEEL[4], B.LOKESH[5], K.MONIKA MADHUVARA[6]

[1]Assistant Professor,Department of ELECTRICAL & ELECTRONICS ENGINEERING, SANKETIKA VIDYA PARISHAD ENGINEERING COLLEGE

Email id: palasuresh369@gmail.com

[2], Student of B-TECH, SANKETIKA VIDYA PARISHAD ENGINEERING COLLEGE

(Approved by AICTE, Ministry of HRD, New Delhi & Affiliated to Andhra University, Visakhapatnam), Behind Y.S.R A. C. A-V.D.C.A Stadium, P.M.Palem, Visakhapatnam-530 041.

Email id: Jaguudj143@gmail.com

[3], Student of B-TECH, SANKETIKA VIDYA PARISHAD ENGINEERING COLLEGE

(Approved by AICTE, Ministry of HRD, New Delhi & Affiliated to Andhra University, Visakhapatnam), Behind Y.S.R A. C. A-V.D.C.A Stadium, P.M.Palem, Visakhapatnam-530 041.

Email id: paltetisunil95@gmail.com

[4], Student of B-TECH, SANKETIKA VIDYA PARISHAD ENGINEERING COLLEGE

(Approved by AICTE, Ministry of HRD, New Delhi & Affiliated to Andhra University, Visakhapatnam), Behind Y.S.R A. C. A-V.D.C.A Stadium, P.M.Palem, Visakhapatnam-530 041.

Email id: sowsheel125@gmail.com

[5], Student of B-TECH, SANKETIKA VIDYA PARISHAD ENGINEERING COLLEGE

(Approved by AICTE, Ministry of HRD, New Delhi & Affiliated to Andhra University, Visakhapatnam), Behind Y.S.R A. C. A-V.D.C.A Stadium, P.M.Palem, Visakhapatnam-530 041.

Email id: Lokeshlokeeonline@gmail.com

[6], Student of B-TECH, SANKETIKA VIDYA PARISHAD ENGINEERING COLLEGE

(Approved by AICTE, Ministry of HRD, New Delhi & Affiliated to Andhra University, Visakhapatnam), Behind Y.S.R A. C. A-V.D.C.A Stadium, P.M.Palem, Visakhapatnam-530 041.

Email id: monicamadhuvara@gmail.com

ABSTRACT

MULTILEVEL inverters (MLIs) have emerged as a prominent power electronics converter, offering high-quality output at lower switching frequencies, reducing voltage stress, harmonics, electromagnetic interference, and switching losses compared to conventional two-level inverters. MLIs find applications in electric drives, electric vehicles, railways, aircraft, and renewable energy systems. They are classified into single dc-source flying capacitor MLI (FC MLI), single dc-source diode clamped MLI (DC MLI), and multiple dc-sources cascaded H-bridge MLI (CHB MLI). CHB MLI, known for voltage balancing, design simplicity, and cost-effectiveness, is widely preferred for low to high voltage applications (>10 kV). Researchers focus on reducing semiconductor switch count in MLIs, leading to topologies with half the switches of conventional CHB MLIs. However, increased voltage stress limits their use in high voltage applications. Optimized MLI structures with fewer switches capable of synthesizing multiple levels at the output have been developed, addressing voltage stress concerns and inherently generating negative levels. Authors present new MLI topologies to reduce voltage stress and device count while maintaining performance

Keywords: dc-source diode clamped MLI (DC MLI),

1. INTRODUCTION

The utilization of dc sources of suitable magnitudes is a well-established method for generating multiple output levels. The topologies mentioned employ this approach, with authors developing algorithms to determine dc source magnitudes for synthesizing desired output voltage levels. Selecting suitable algorithms is crucial for maximizing levels while minimizing voltage stress on switches. In addition to popular H-bridge-based MLIs, designing hybrid MLI structures is a current research focus. For example, compact module type MLIs and packed U cell MLIs produce multilevel outputs without H-bridges, allowing cascading of modules/basic units to increase levels. The invention of level doubling circuits (LDCs) significantly advances MLI technology, doubling levels with the same active switch count when integrated with MLIs of different voltage magnitudes. Various pulse width modulation (PWM) schemes have been developed to control voltage and current quality by generating appropriate switching pulses for MLIs. PWM control techniques are broadly categorized into high switching frequency and fundamental/low switching frequency control techniques, depending on operating frequencyThe utilization of dc sources of suitable magnitudes is a well-established method for generating multiple output levels. The topologies mentioned employ this approach, with authors developing algorithms to determine dc source magnitudes for synthesizing desired output voltage levels. Selecting suitable algorithms is crucial for maximizing levels while minimizing voltage stress on switches. In addition to popular H-bridge-based MLIs, designing hybrid MLI structures is a current research focus. For example, compact module type MLIs and packed U cell MLIs produce multilevel outputs without H-bridges, allowing cascading of modules/basic units to increase levels. The invention of level doubling circuits (LDCs) significantly advances MLI technology, doubling levels with the same active switch count when integrated with MLIs of different voltage magnitudes. Various pulse width modulation (PWM) schemes have been developed to control voltage and current quality by generating appropriate switching pulses for MLIs. PWM control techniques are broadly categorized into high switching frequency and fundamental/low switching frequency control techniques, depending on operating frequency

2. LITERATURE SURVEY AND RELATED WORK

Reducing the life-threatening acts and providing high security are challenging at every place. Therefore, a number of researchers have contributed to monitoring various activities and behaviors using object detection. In general, a framework of smart surveillance system is developed on three levels: firstly, to extract low-level information like features engineering and object tracking; secondly, to identify unusual human activities, behavior, or detection of any weapon; and finally, the high level is about decision making like abnormal event detection or any anomaly. The latest anomaly detection techniques can be divided into two groups, which are object-centered techniques and integrated methods. The convolutional neural network (CNN) spatial-temporal system is only applied to spatial-temporal volumes of interest (SVOI), reducing the cost of processing. In surveillance videos of complex scenes, researchers in proposed a tool for detecting and finding anomalous activities. By conducting spatial-temporal convolution layer, this architecture helps one to capture objects from both time domain and frequency domain, thereby extracting both the presence and motion data encoded in continuous frames. To do traditional functions to local noise and improve detection precision, spatial-temporal convolution layers are only implemented within spatial-temporal quantities of changing pixels. Researchers proposed anomaly-introduced learning method for detecting anomalous activities by developing multi-instance learning graph-based model with abnormal and normal bimodal data, highlighting the positive instances by training coarse filter using kernel-SVM classifier and generating improved dictionary learning known as anchor dictionary learning.

Thus, abnormality is measure by selecting the sparse reconstruction cost which yields the comparison with other techniques including utilizing abnormal information and reducing time and cost for SRC.

2.2 Huetal have contributed in “detecting various objects in traffic scenes by presenting a method which detects the objects in three steps”.

Initially, it detects the objects, recognizes the objects, and finally tracks the objects in motion by mainly targeting three classes of different objects including cars, cyclists, and traffic signs. Therefore, all the objects are detected using single learning-based detection framework consisting of dense feature extractor and trimodal class detection. Additionally, dense features are extracted and shared with the rest of detectors which heads to be faster in speed that further needs to be evaluated in testing phase. Therefore, intra class variation of objects is proposed for object sub-categorization with competitive performance on several datasets.

2.3 .Gregaetal presented an “algorithm which automatically detects knives and firearms in CCTV image and alerts the security guard or operator” .[2]

Majorly, focusing on limiting false alarms and providing a real-time application where specificity of the algorithm is 94.93% and sensitivity is 81.18% for 9 knife detection. Moreover, specificity for fire alarm system is 96.69% and sensitivity is 35.98% for different objects in the video. Mousavi et al. in carried out video classifier also referred to as the Histogram of Directed Tracklets which identifies irregular conditions in complex scenes.

In comparison to traditional approaches using optical flow which only measure edge features from two subsequent frames, descriptors have been developing over long-range motion projections called tracklets. Spatiotemporal cuboid footage sequences are statistically gathered on the tracklets that move through them.

2.4 .Jietal developed a system for security footage which automatically “identifies the human behavior using convolutional neural nets (CNNs)”.[3]

By using deep learning model which operates directly on the raw inputs . Therefore, 3D CNN model for classification requires the regularization of outputs with high-level characteristics to increase efficiency and integrating the observations of a variety of various models.

3. IMPLMENTATION STUDY

The first proposed structure (PS1) is the cascaded arrangement of proposed RSHB MLI and LDC1. The LDC in PS1 is nothing but a semi-H-bridge consisting of two switches and one capacitor. The switches K1 and K2 in LDC1 should turn ON alternatively to avoid short-circuiting of the source. Moreover, K1 mostly operates in the positive half cycle and K2 for the negative half cycle. With just two additional switches, it is possible to almost double the number of levels compared to the output produced by the RSHB MLI. For instance, PS1 generates a 17-level staircase output using only nine switches (three repeating units, one H-bridge and LDC1). Generalized expressions for the switch count (Nsw), number of discrete diodes (Ndd), number of dc sources/dc-link capacitors (Ndcs), and number of levels (Nl) in terms of the number of repeating units are given.

$N_{sw} = n + 6$

$N_{dd} = n$

$N_{dcs} = 2n + 1$

$N_l = 4n + 5$

To generate a particular level, LDC can reduce the need for many switches and PS1 can achieve a drastic reduction in the device count. The case study of this work is done based on PS1 for generating a 17-level in the output. A 17-level staircase output and the switching states are illustrated

3.1 PROPOSED MODEL

A generalized schematic view of the proposed reduced switch H-bridge based (RSHB) MLI with LDC . The RSHB MLI is the combination of several repeating units (1, 2, …, n) with an H-bridge in which the repeating unit contains two dc sources, one semiconductor switch, and one diode. In general, the RSHB MLI can produce $2n + 3$ levels at the output using n repeating units. Switches and diodes in the repeating unit cannot conduct simultaneously. For a single repeating unit, when the switch Sn is off the output will be Vdc/n. But, when the switch Sn turns on the output (Vrn) will be Vdc + Vdc/n, where Vcr1, Vcr2, Vcrn = Vdc, and Vcr1/n, Vcr2/n, Vcrn/n = Vdc/n. T1 & T2 are responsible for the positive polarity generation and T3 & T4 are responsible for reversing the polarity.

4. METHODOLOGIES & Algorithm

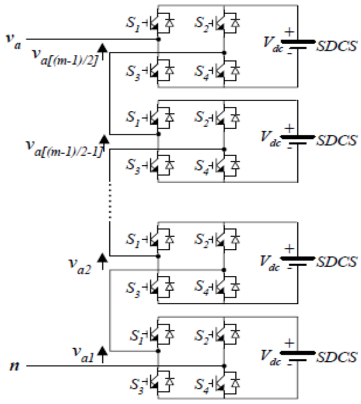
An inverter is an electrical device that converts direct current (DC) to alternating current (AC); the converted AC can be at any required voltage and frequency with the use of appropriate transformers, switching, and control circuits

Static inverters have no moving parts and are used in a wide range of applications, from small switching power supplies in computers, to large electric utility high-voltage direct current applications that transport bulk power. Inverters are commonly used to supply AC power from DC sources such as solar panels or batteries. The electrical inverter is a high-power electronic oscillator. It is so named because early mechanical AC to DC converters were made to work in reverse, and thus were "inverted", to convert DC to AC.The inverter performs the opposite function of a rectifier

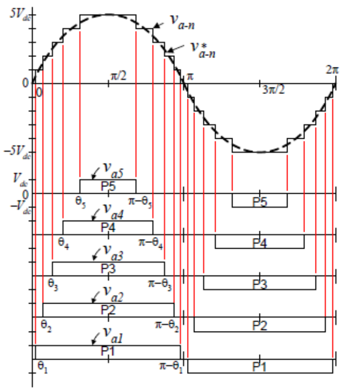
4.1 Cascaded H-Bridges inverter A single-phase structure of an m-level cascaded inverter is illustrated . Each separate dc source (SDCS) is connected to a single-phase full-bridge, or H-bridge, inverter. Each inverter level can generate three different voltage outputs, $+V_{dc}$, 0, and $-V_{dc}$ by connecting the dc source to the ac output by different combinations of the four switches, S_1, S_2, S_3, and S_4. To obtain $+V_{dc}$, switches S_1 and S_4 are turned on, whereas $-V_{dc}$ can be obtained by turning on switches S_2 and S_3. By turning on S_1 and S_2 or S_3 and S_4, the output voltage is 0. The ac outputs of each of the different full-bridge inverter levels are connected in series such that the synthesized voltage waveform is the sum of the inverter outputs. The number of output phase voltage levels m in a cascade inverter is defined by m = 2s+1, where s is the number of separate dc sources. An example phase voltage waveform for an 11-level cascaded H-bridge inverter with 5 SDCSs and 5 full bridges The phase voltage $v_{an} = v_{a1} + v_{a2} + v_{a3} + v_{a4} + v_{a5}$.

For a stepped waveform such as the one depicted with s steps, the Fourier Transform for this waveform follows

$$V(\omega t) = \frac{4V_{dc}}{\pi} \sum_n \left[\cos(n\theta_1) + \cos(n\theta_2) + \ldots + \cos(n\theta_s)\right] \frac{\sin(n\omega t)}{n}, \quad \text{where } n = 1, 3, 5, 7, \ldots$$



Single-phase structure of a multilevel cascaded H-bridges inverter



Output phase voltage waveform of an 11-level cascade inverter with 5 separate dc sources.

The magnitudes of the Fourier coefficients when normalized with respect to V_{dc} are as follows:

$$H(n) = \frac{4}{\pi n}\left[\cos(n\theta_1) + \cos(n\theta_2) + \ldots + \cos(n\theta_s)\right], \quad \text{where } n = 1, 3, 5, 7, \ldots$$

The conducting angles, θ_1, θ_2, ..., θ_s, can be chosen such that the voltage total harmonic distortion is a minimum. Generally, these angles are chosen so that predominant lower frequency harmonics, 5th, 7th, 11th, and 13th, harmonics are eliminated. More detail on harmonic elimination techniques will be presented in the next section.

Multilevel cascaded inverters have been proposed for such applications as static var generation, an interface with renewable energy sources, and for battery-based applications. Three-phase cascaded inverters can be connected in wye, , or in delta. Peng has demonstrated a prototype multilevel cascaded static var generator connected in parallel with the electrical system that could supply or draw reactive current from an electrical system. The inverter could be controlled to either regulate the power factor of the current drawn from the source or the bus voltage of the electrical system where the inverter was connected.have also shown that a cascade inverter can be directly connected in series with the electrical system for static var compensation. Cascaded inverters are ideal for connecting renewable energy sources with an ac grid, because of the need for separate dc sources, which is the case in applications such as photovoltaics' or fuel cells.

5 RESULTS AND DISCUSSION SCREEN SHOTS

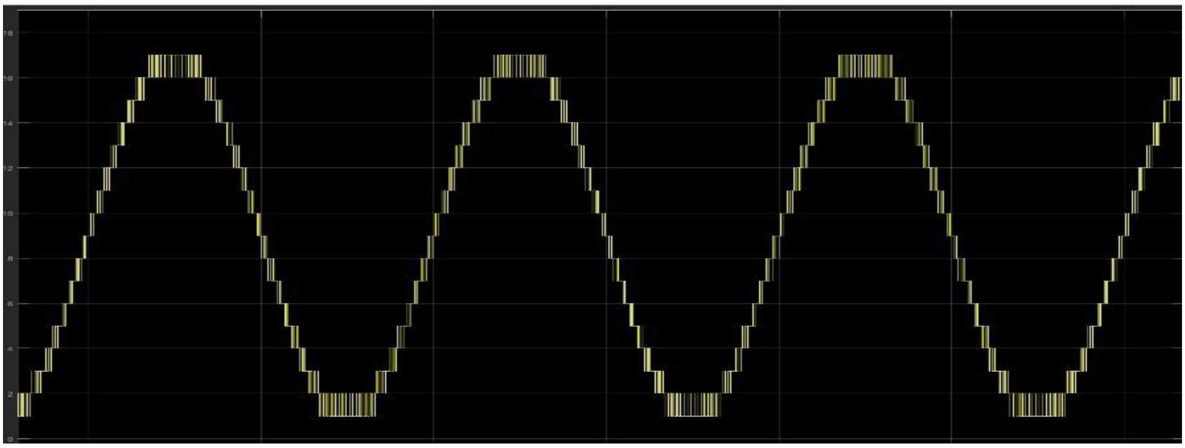


Figure 1 Behaviour of PI sysytem under voltage sag/swell condition

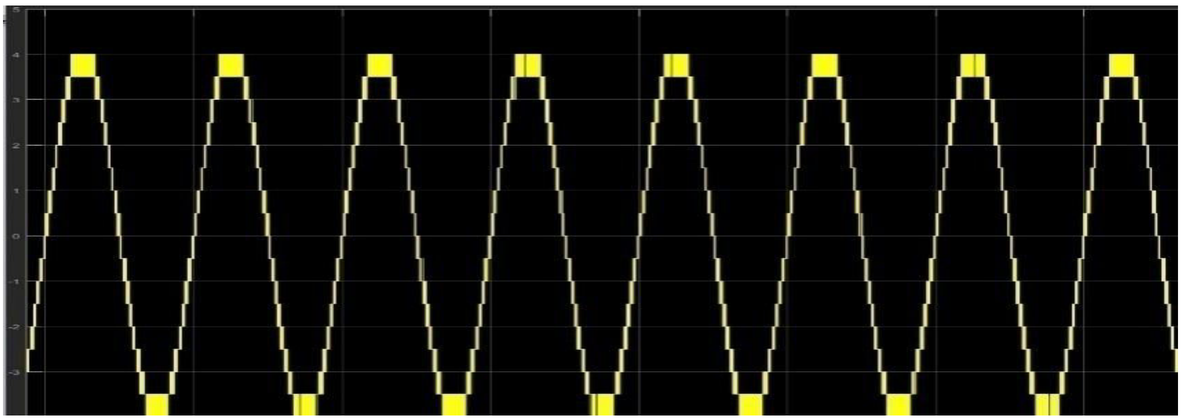


Figure.2 PI logical output waveform

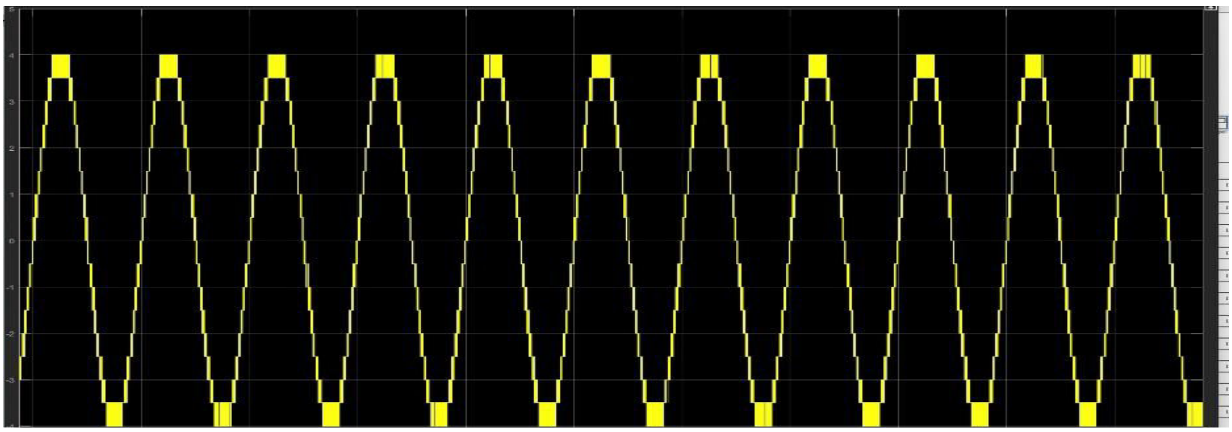


Figure 3 Fuzzy logical output waveform

6. CONCLUSION

This paper presents a technique of Fuzzy logic based control statergy for PI is presented here. The overall performance and efficiency of the system are investigated through simulation.The shunt compensator is working satisfactorily under suddenly varying load and load unbalanced conditions and makes the grid current sinusoidal by successfully compensating for load reactive power demand, load harmonics. series compensator effieciently compensates higher order harmonics in source voltage.The load terminal is maintained at the rated value by the series compensator under sudden variation in grid voltage level (sag and swell). Also, the series compensator successfully eliminates the harmonics present in thr source side and prevents it from reaching to the load side.The performance of the proposed scheme is further enhanced by the incorporation of PV array. Burden on the grid is reduced due to the interconnection of pv array.Under load defict condition, PV array feeds extra generated power to the source.Under voltage swell, the performance of power quality is improved.