



Application Of Power Electronic Multi Level Inverters For Enhancing Power Quality Of Grid Connected Hybrid Power System

¹Reshma Sulthana S S, ² Shabana S S

^{1,2} Senior Grade Lecturer

Government polytechnic, Bellary, Bellary, India

Abstract:

For India to become a developed country, and to urbanize, the need for energy is increasing. Sustainable energy resources being abundant and freely available in nature, can be trusted to be of more advantage than the traditional ones. Among these sun and wind energy are abundantly accessible and are treated as reliable sources for energy production. Rural areas electrification of as well as for upgrading remote area, hybrid solar and wind energy systems can be used. This work does a study of hardware modelling along with simulation of a grid connected hybrid solar and wind power plants. To analyze this, calculation of the dip, increase, voltage(Vs), current(Is), and THD %age is done using a simulated model. The Solar electricity generated is in dc, by using a seven stage converter the dc is transformed to ac. The benefit of seven inverters is that, it enhances the system's total power quality. For the system suggested here, simulation is done using a math lab (Matlab) Program, also the investigation of the design of a seven level inverter is done.

Keywords: Renewable energy, Multi level Inverter, Matlab simulation, THD.

I. INTRODUCTION

Sustainable energy resources being abundant and freely available in nature .Numerous new control tactics are used for enhancing power quality and reliability of energy obtained from these energy resources .Power electronics controller technology are important in small energy generation and for integrating non-conventional energy generation to grid. Of lately, sun energy and wind energy production has been of superior interest. The non-renewable energy resources are being exhausted at a faster rate and also the cost of these fuels is swelling rapidly. The solar power output is dc, which is then transformed to ac by using inverters. Multilevel inverters are used for decreasing the harmonics. In, the method proposed in the paper, seven level H-bridge multilevel inverter is applied for enhancing of power quality. In the proposed scheme wind power is c o n n e c t e d directly connected to the grid , while the output of solar energy is linked to the grid through seven level inverter and then Simulation work is carried out.

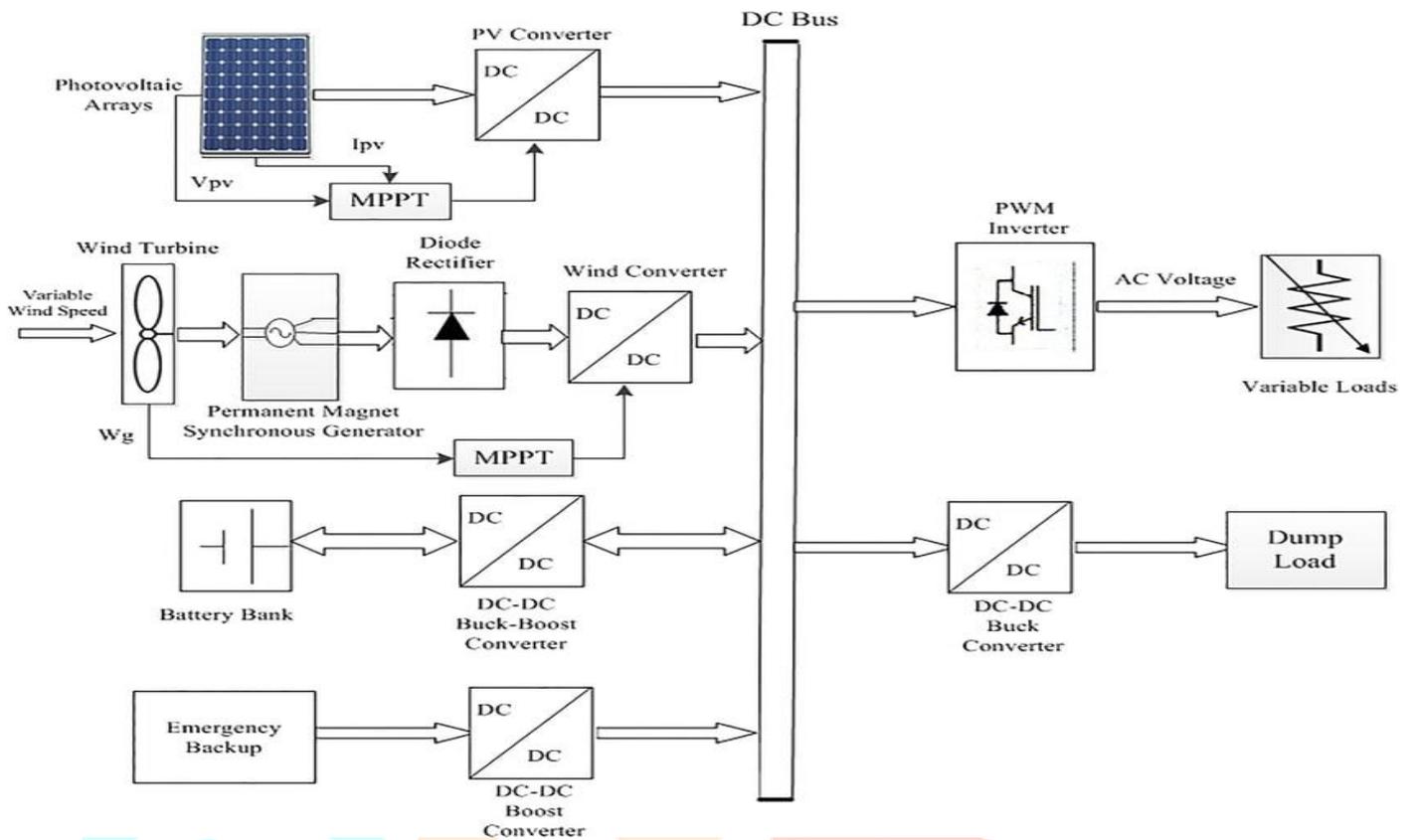
II. LITERATURE REVIEW:

Lots of modelling in addition to planning has been done for PV and Wind systems by applying diverse methods. [2] The author states that the PV-Wind design can be categorized into two, (i) grid or (ii) standalone. The proposed system of PV-Wind energy system uses a wind mill, a wind side converter, a DC-DC converter and a grid inverter interface. MPPT is used to enhance the direct voltage from the solar panels output. The proposal was executed in the MATLAB setting using Simulink software. [2] A hybrid power system is a structural plan of crossbreeding power supply components or their combination, for ex. positioning different power sources to generate in parallel. Thus, hybridization is well-defined as the forming a cross between sets of agents to work collectively for a purpose. Therefore, hybridization means the manual or automatic synchronization of two or more sources or components of an electrical power generator to source electrical energy to the grid, creating a hybrid power generation. [10] Overall, a HRES uses a various sources for supplying power to the electrical system. [2] The HRES system has different strategies or

prototypes that consist of five mutual sub-units namely (i) non-conventional energy source (ii) electrical system and (iii) energy storage system (ESS), however (iv) a common bus is included for system management and (v) an electronic logic controller (ECS). HRES enhancement and component size were found to be cost effective and dependably superior in all output circumstances with minimal capital besides operating costs. The integration of sun energy, wind energy and additional renewables with power storage as a crossbreed system has the financial returns of delivering satisfactory performance, conservational affability along with dependability for all output situations. [16] A grid-connected seven-level cascaded inverter is studied for % THD voltage and current. The designed scheme is demonstrated and simulation is done using MATLAB / SIMULINK software. An L - C filter circuit is used on the output end to additionally lessen the THD %age. A 7-level multilevel inverter to convert dc to ac for feeding the energy produced from the solar panels to the grid. Cascaded multilevel converters are mostly applied in moderate to large power applications such as stationary reactive power compensators. [5] Present state of study is on optimum size of stand-alone hybrid sun-wind energy systems. Sun and wind power systems are ubiquitous, easily accessible, environmentally beneficial and are thought to be favorable energy production sources because of their convenience and topological benefits for indigenous energy generators. The hybrid sun-wind power systems utilize two nonconventional energy resources, which gives enhanced power efficiency and power dependability, and reducing power storing necessities for stand-alone type systems. [6] Hybrid sun-wind arrangements are getting prevalent in isolated areas energy generations because of advancement in non-conventional energy technology and significant increases in petroleum product cost. The aim of this paper being, assessment of the present state of simulating, optimizing and control technology in case of stand-alone hybrid sun and wind energy systems provided with battery storing capacity. It remains that further exploration and progress efforts in these fields are required to improve the efficiency of the systems, to develop techniques to accurately predict their performance, and to reliably integrate these with different non-conventional energy sources. [12] Power quality problems in a hybrid power organization: The subject investigation was the quality of electricity and local load. From the consumer's view point, high quality power on the consumer end is vital. The main purpose here is to demonstrate the effect of wind plant on the whole scheme. Also, wind mill startup and transitory conditions through load deviations disturb system voltage(V) and frequency(f). Cascaded multi-level inverter topologies for Stand-alone PV Systems: Versatile standalone solar(PV) system require minimum one battery storage inverter with enhanced robustness and efficiency features, these can be realized by means of multilevel inverter topologies. The 3 kVA prototype provides a peak efficiency of 96.0%. Hybrid non-conventional energy Bus: The electrical bus is used to transport electrical energy from the generation/energy conversion to the grid. There are two bus levels, AC and DC which are basically of two types of configurations, viz. serial and parallel buses.

III. METHODOLOGY:

The block diagram is as seen in figure 1. A grid connected Solar-Wind system proposed uses Wind generator with maximum power points tracking (MPPT), PV array output connected to DC-AC converter for converting dc of the PV to ac power, and load. The MPPT is used to capture the Pmax power available at the wind turbine. The scheme was executed in Matlab.



The suggested arrangement comprises of wind energy that is directly connected to the grid. The PV output is connected to the grid using cascaded multilevel inverter. Multilevel inverter are used to convert dc to ac and for reduction in THD. Power quality• Power quality denotes the capability of electrical apparatus to consume the power provided to it. A variety of power quality concerns control the efficiency of electrical apparatus that include electric harmonics, reduced power factor, voltage instability, and unbalance. Managing energy consumption is a significant factor in any industry and it is crucial that quality of power is measured as quantity of any energy managing approach. Harmonic voltage and current are presented by many day to day electrical apparatus, these will distort the shape of the alternating current and increase power consumption. By applying harmonic filter circuits or chokes, harmonics are removed and the outcome is further competent for use of energy.

IV. RESULTS AND DISCUSSIONS:

Figure 2 indicates the without controller waveform plot V_s, I_s and the load with respect to time. The inference is that V_s is sinusoidal and I_s and I_L are non-sinusoidal.

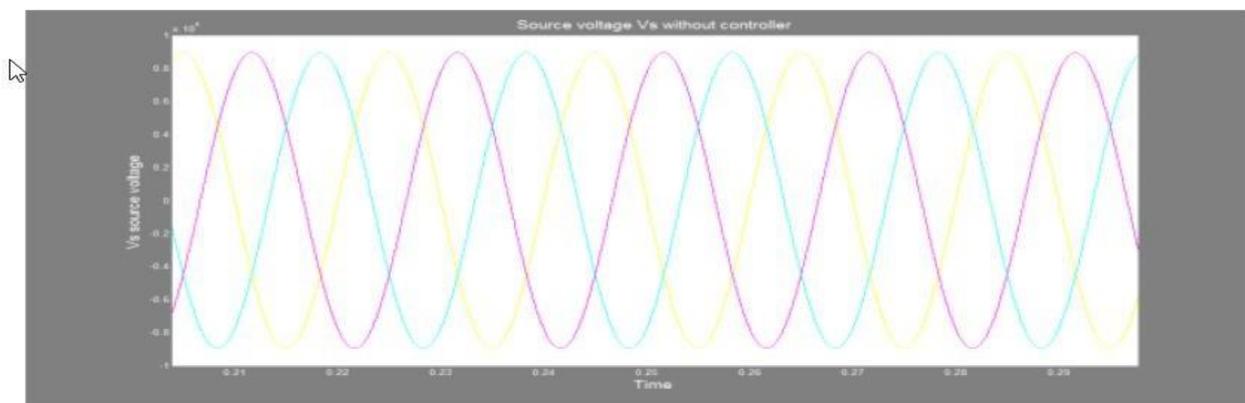


Figure 2 Waveform without Controller

Figure 3 indicates waveforms of V_s, I_s and I_L with controller. In is seen that I_s and I_L are more sinusoidal compared to without controller.

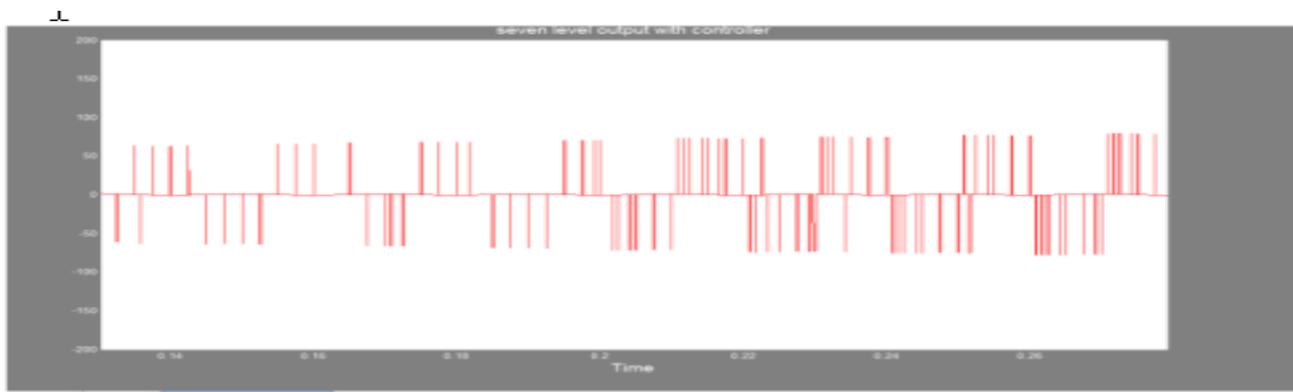


Figure 3 Waveform with Controller

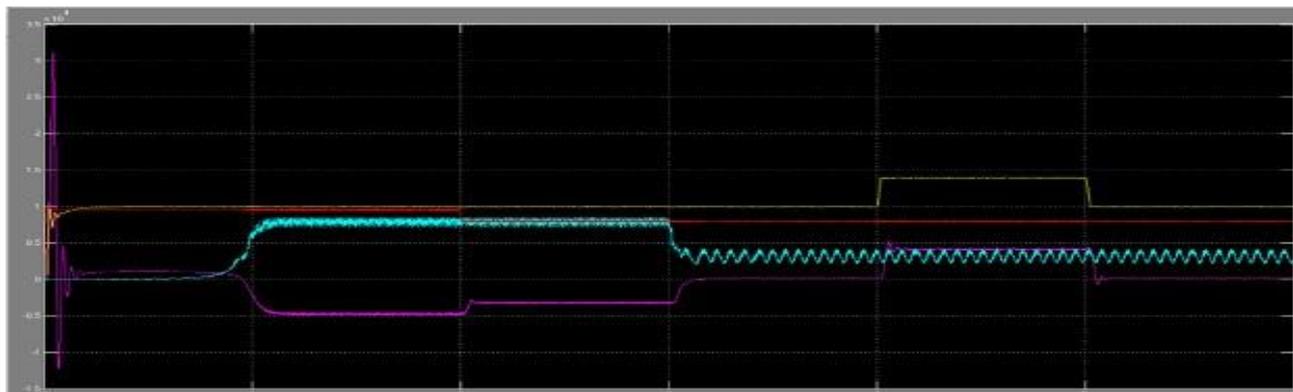


Figure 4 power generated by the system when connected to grid, L_p , B_p , S_p and W_p .

Figure 5 shows the output waveform at the control of inverter whose input is from the LC filter and the generated output pulses are given to the gate of the PWM inverter.

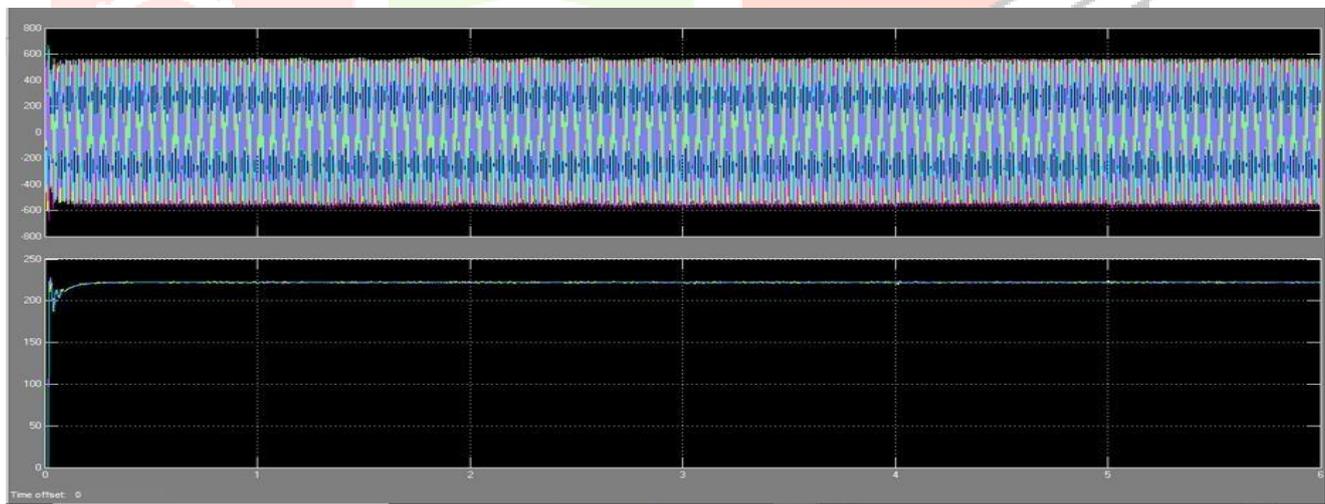


Figure 5 output at the control of Inverter

Figure 7 (a) THD in a 7 level multi inverter (b) THD in 5 level multi inverter

Figure 7 a & b shows waveform for THD in a seven level multi inverter and five level multi inverter respectively. It can be seen that by using a seven level multi inverter the Total harmonic Distortion (THD) is reduced by 3%.

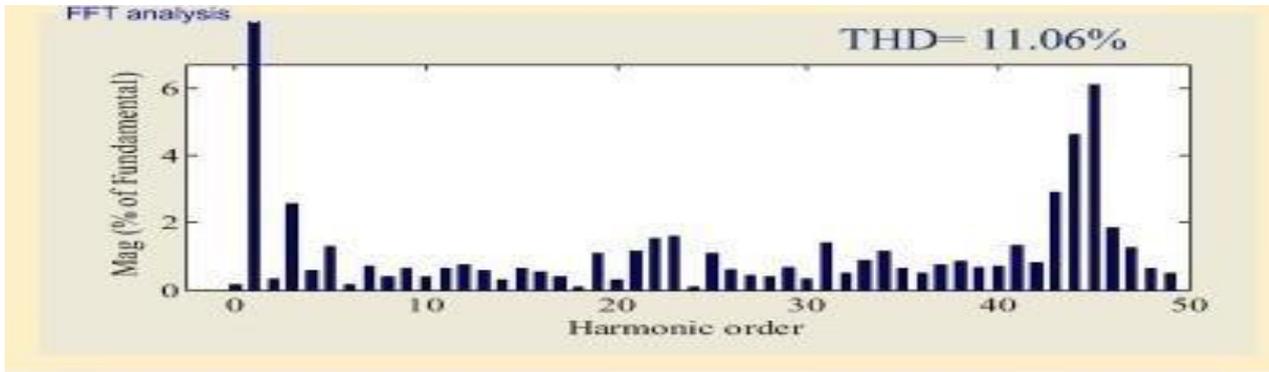


Figure 7 a

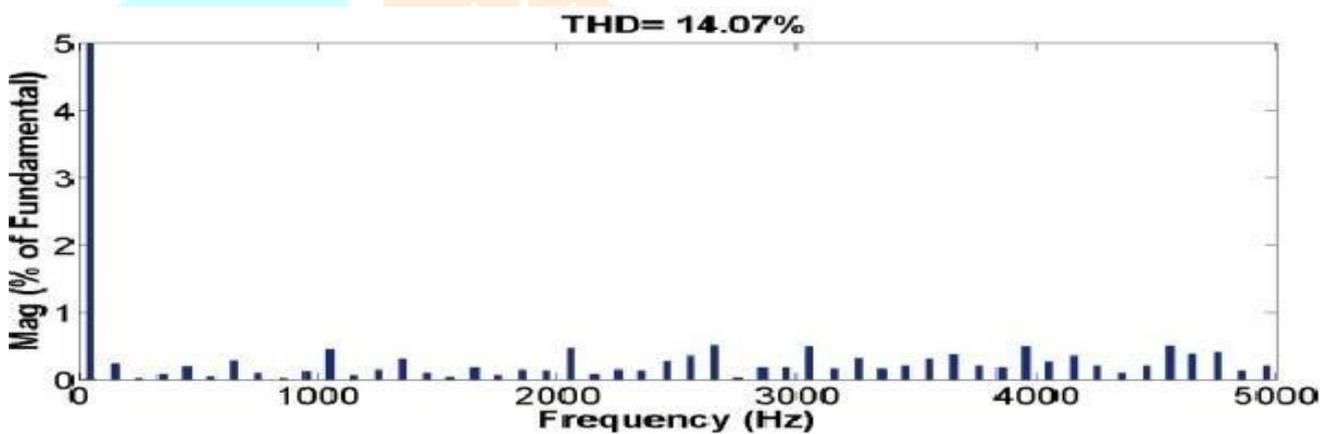


Figure 7 b

V. CONCLUSION

In this scheme enhancing of power quality of grid connected hybrid power systems has been carried out.

The solar power produced is dc and hence has to be provided to the load by use of seven level inverter at PV. The seven level inverter is applied for reactive power compensation at solar output and to avoid the voltage dip and increase due to fluctuations of the load. For simulation of the suggested project MATLAB software with Simulink is adapted. Hence, it can be concluded that: With the use of controller, non-sinusoidal V_s , I_s and I_L converted to sinusoidal. The controller moderates the reactive power output of PV source thereby enhancing THD of the suggested power scheme. The amount of voltage dip and increase of line RMS voltage at point of common coupling owing to rapid variation of load was also observed from the simulation of the system under study. Total harmonic Distortion (THD) is reduced by 3%. With use of multilevel inverters, as the number of level increases the distortion is decreased.

VI. FUTURE WORK

The output power from the wind power plant varies with the rate of change of speed and hence study of this project can be supported by applying methods such as pitch angle control subsequently so as to obtain constant power from wind power plant. Focus is also needed in developing efficient battery technology for energy storage in smart grid systems. Total harmonic distortion will be reduced by approx. 3% so as to enhance the total power quality of solar and wind energy generators. Various factors that affect the effectiveness of the hybrid scheme such as the tilt angle of PV arrays within the solar panels also finds a scope for future work

VII. REFERENCES:

- [1] Mr. Akshay Zade, Dr. Asha Gaikwad, "Study of THO for various kinds of Loads Connected to The Distribution System". Spvryan's International Journal of Engineering Sciences & Technology (SEST) ISSN: 2394-0905, Issue 3 Volume 2, may - 2015.
- [2] Mr. Akshay Zade, Dr. Asha Gaikwad, "Design and simulation analysis of seven level Cascaded grid connected inverter for PV system" Novateur publications International journal of innovations in engineering research and technology [IJIERT] ISSN: 2394-3696 volume 2, issue 10, oct.-2015
- [3] Ku. Tejashri Rachcha, Dr. Asha Gaikwad, Naresh Dhopare, "Magnetically Levitated Solar Motor" 2015 2nd International Conference on Computing for Sustainable Global Development (INDIACom), 978-9-3805-4416-8/i5/\$31.00c 2015 IEEE.
- [4] Juan Manuel Carrasco, Leopoldo Garcia Franquelo, Fellow, Jan T. Bialasiewicz, Eduardo Galvan, Ramon C. Portillo Guisado, Ma. Angeles Martin Prats, and Narciso Moreno-Alfonso, Member, IEEE, "Power Electronic Systems for the Grid Integration of Renewable Energy Sources: A Survey". IEEE TRANSACTIONS ON INDUSTRIAL ELECTRONICS, VOL. 53, NO.4, AUGUST 2006.
- [5] A. Khadar, T. M. Hayath and M. S. Nagraj, "Design and implementation of ZigBee based smart grid system for power management," 2017 International Conference On Smart Technologies For Smart Nation (SmartTechCon), 2017, pp. 1339-1343, doi: 10.1109/SmartTechCon.2017.8358584.
- [6] T. M. Hayath, Dadapeer, S. G. Tejashwini and N. M. Indravan, "Design of auto wakeup alarming system for commuters in railway sleeper coaches," 2017 International Conference On Smart Technologies For Smart Nation (SmartTechCon), 2017, pp. 671-674, doi: 10.1109/SmartTechCon.2017.8358456.
- [7] Samir Kouro, Jaime Rebolledo, and Jose Rodriguez, "Reduced Switching-Frequency Modulation Algorithm for High-Power Multilevel Inverters". IEEE TRANSACTIONS ON INDUSTRIAL ELECTRONICS, VOL. 54, NO.5, OCTOBER 2007.
- [8] Yu Liu, Student Member, IEEE, Hoon Hong, and Alex Q. Huang, Fellow, IEEE, "Real-Time Calculation of Switching Angles Minimizing THD for Multilevel Inverters With Step Modulation". IEEE TRANSACTIONS ON INDUSTRIAL ELECTRONICS, VOL. 56, NO.2, FEBRUARY 2009.
- [9] User Interfaces in C#: Windows Forms and Custom Controls by Matthew MacDonald.
- [10] Applied Microsoft® .NET Framework Programming (Pro-Developer) by Jeffrey Richter.
- [11] Practical .Net2 and C#2: Harness the Platform, the Language, and the Framework by Patrick Smacchia.
- [12] Data Communications and Networking, by Behrouz A Forouzan.

[13] Computer Networking: A Top-Down Approach, by James F. Kurose.

[14] Operating System Concepts, by Abraham Silberschatz.

[15] M. Armbrust, A. Fox, R. Griffith, A. D. Joseph, R. H. Katz, A. Konwinski, G. Lee, D. A. Patterson, A. Rabkin, I. Stoica, and M. Zaharia, "Above the clouds: A berkeley view of cloud computing," University of California, Berkeley, Tech. Rep. USB-EECS-2009-28, Feb 2009.

[16] "The apache cassandra project," <http://cassandra.apache.org/>.

[17] L. Lamport, "The part-time parliament," ACM Transactions on Computer Systems, vol. 16, pp. 133–169, 1998.

