SOLAR PV SYSTEMS BASED GRID INTEGRATION ISSUES USING ANFIS ALGORITHM

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Abstract:

This research describes and analyzes an energy management system (EMS) for a grid-connected photovoltaic Solar system that relies on the Adaptive Neuro-fuzzy Inference System (ANFIS). In this project, an examination of a PV system with MPPT control that is connected to the grid is presented. A scheme with Mppt algorithm is modeled in precise detail. The simulations results indicate that the ANFIS model, which is recommended as an MPPT algorithm for Photovoltaic module, can be utilized more efficiently than some other methods currently in use.

Keywords: Adaptive Neuro Fuzzy Interference System (ANFIS), Maximum power point tracking (MPPT), Photovoltaic (PV), DC/DC Converters, Three stage inverter.

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1. Introduction:

A significant contribution is made by renewable energy sources in the generation of electricity. As humanity shift from large centralized conventional power plants to limited functions sustainable power plants, energy systems are going through major shifts. In actual, the application of Incorporated Renewable Energy Providing insight in these small power plants (IRES). Future energy needs might move towards renewable energies (RES) like solar and wind. The fact that India is a globe nation helps in balancing the irregular output of renewable energy sources located in a few states by integrating them into all of India's systems. As of August 31, 2018, the state of Tamil Nadu generated 11654 MW of grid-interactive RES power, with a capacity of 2365.627 MW from solar PV.

Since the efficiency of the PV module is low, it is desirable to function the system at its peak output so that the load can receive the greatest to which under a variation of temp and irradiance situations. Thus, maximizing power increases the solar PV module's efficiency. The solar PV module's maximum power is extracted and sent to the load using a maximum power point tracker (MPPT). The function of a DC/DC converter (step up/step down) is to provide the maximum amount of power from the solar PV module to the load. To guarantee that the panel output always occurs at the maximum power point, maximum power point tracking is used.

Artificial neural networks and fuzzy logic controllers are the two primary AI techniques for MPPT. In this paper, an ANFIS-based MPPT system that interfaces with an open loop boost converter is designed and implemented. ANFIS effectively deals because it combines the benefits of neural networks and fuzzy logic.

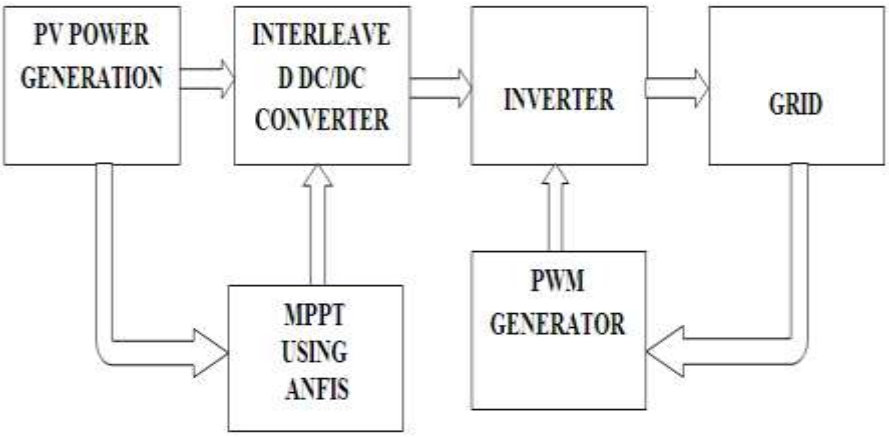


Fig.1.Block Diagram of Proposed System

Implementation Of Proposed System

The solar Photovoltaic system, DC-DC boost converter, proportional integral (PI) controller, PWM signal generator, and ANFIS reference model make up the MPPT's block diagram. Both operational heat and irradiation level are employed as inputs for the ANFIS reference model. The ANFIS reference model provides an exact value for the maximum power that a PV module may generate at a given temperature and irradiance level. By applying a multiplication algorithm to measured operational currents and voltages at the same irradiance level and temperature level, the absolute output power from the Photovoltaic panel is obtained. To create control commands, a proportional plus integral (PI) system receives the mistake from the comparison of the two powers. The PWM generator collects the control signals generated by the PI controller. The obtained PWM signals manage the duty cycle of the DC-DC boost converter to modify the PV component's operating temperature.

ANFIS Fuzzy Interface System

Within adaptive systems that facilitate training and learning, ANFIS is a Sugeno network. While using expert knowledge and a methodology, simulations become much more structured and the user also isn't required to be an expert. An artificial neural network that is built on the Takagi-Sugeno fuzzy inference system is known as an Adaptive Neuro-fuzzy Inference System (ANFIS) or Adaptive Network-based Fuzzy Inference System (ANFIS). It has the ability to combine the advantages of neural networks and fuzzy logic in an unified model because it blends both of these concepts. Its inference system is a collection of IF-THEN fuzzy rules with the ability to learn and approximate nonlinear functions.

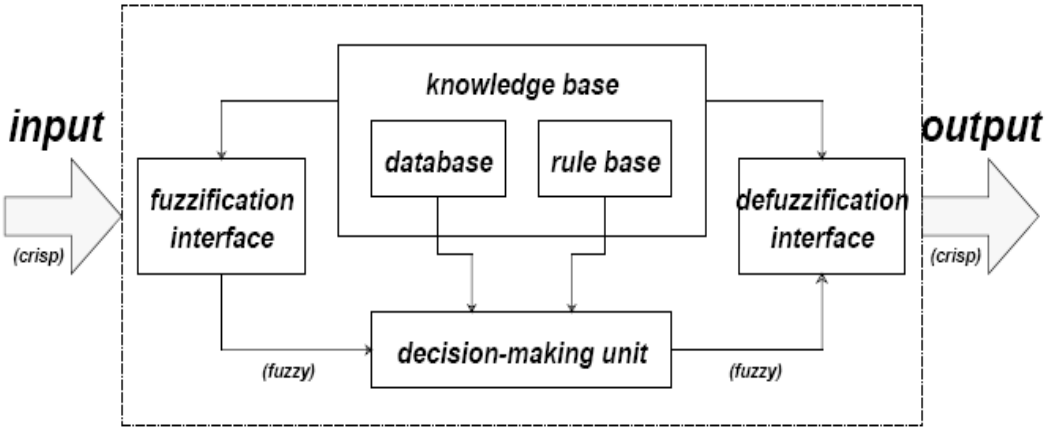


Fig.2. Block of ANFIZ Fuzzy System

MPPT algorithm

Because of the fact that the MPP of a solar panel changes with irradiation and temp, MPPT computations are important in PV applications if you wish to obtain the first and most power possible from an energy from the sun panel. Maximum power point tracking (MPPT) is an algorithm used in photovoltaic (PV) inverters to continuously adjust the impedance seen by the solar array in order to maintain the PV system's performance at, or relatively close to, the peak power point of the PV panels under varying conditions, such as changing solar irradiance, temperature, and load. The P-V bend only has one extreme point under normal circumstances, so it is not a problem. The algorithms take into account factors like changing irradiance (light from the sun).

Simulation of the Proposed System

Software called MATLAB/Simulink is used to model the suggested system. The system is in simulation model as depicted in picture 3.

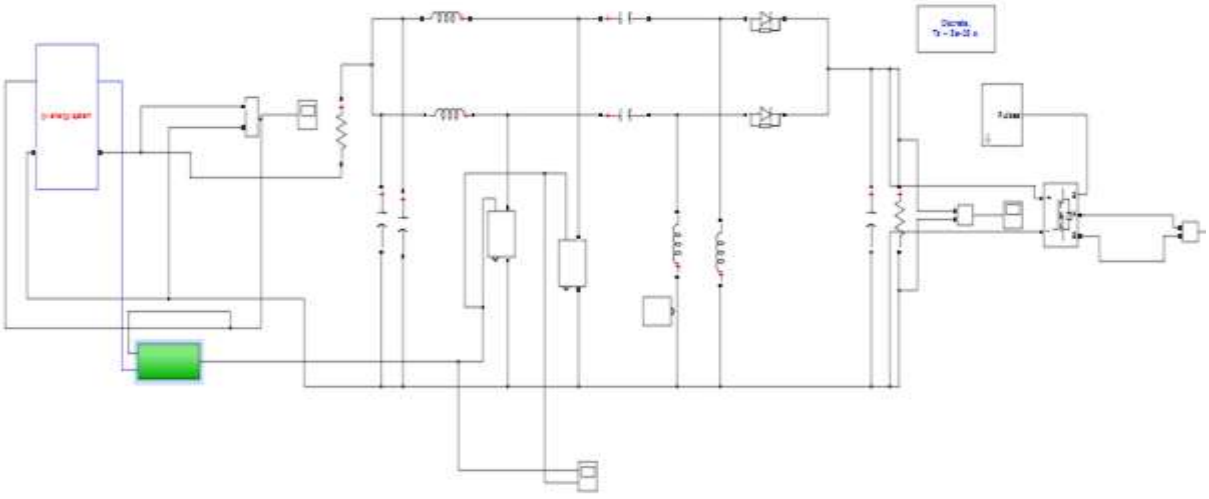


Fig.3. Diagram showing the proposed system's simulation

The system is made up of PV also designed and simulated is the solar system. The solar PV System simulation model is shown on figure.4

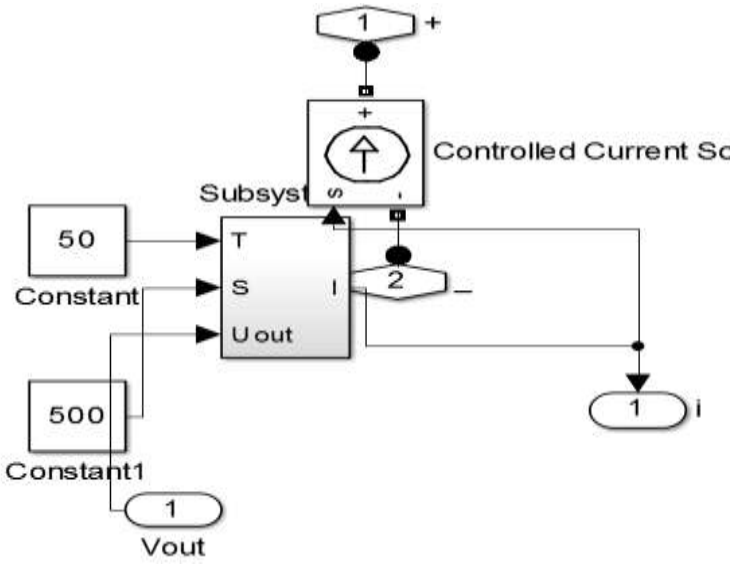


Fig.4. Solar PV system simulation model

The hybrid ANFIS algorithm is a component of the proposed MPPT algorithm. The figure 5 depicts the mppt algorithm.

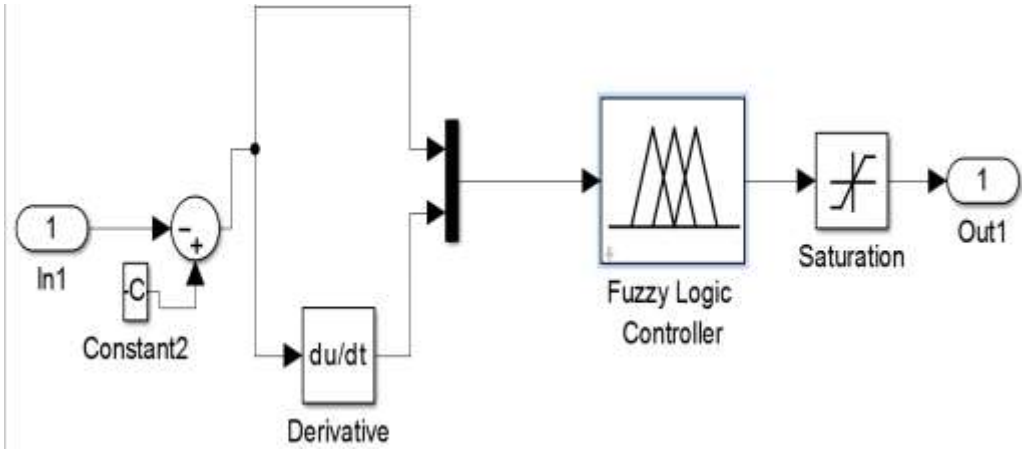


Figure 5. Proposed MPPT Technique simulation model

The algorithm that was used is depicted in figure 6

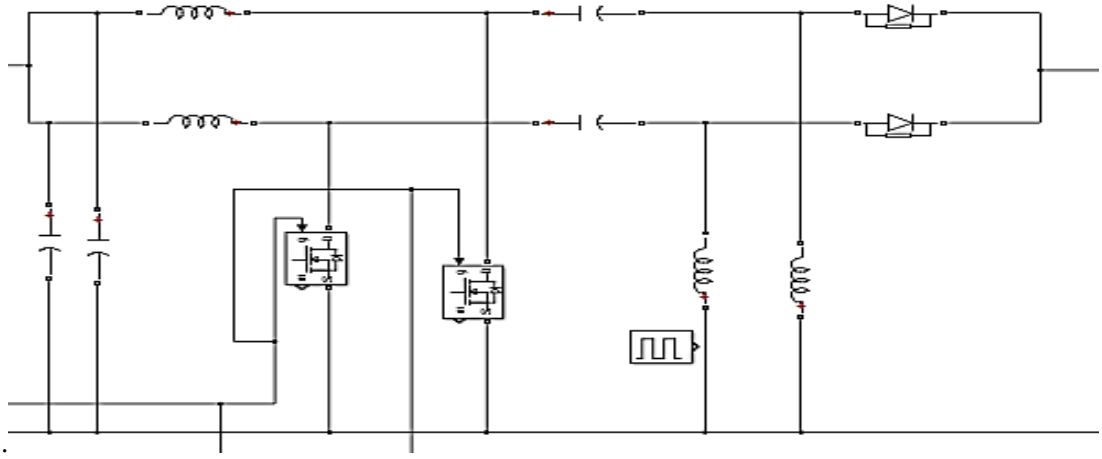
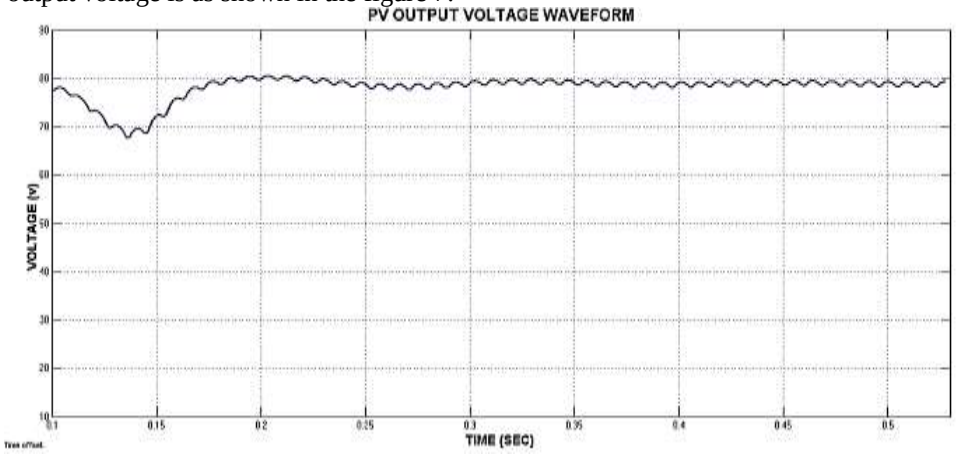


Fig. 6. Simulation model using the MPPT approach and the ANFIS algorithm.

Simulation Results and Output

The proposed system is successfully simulated using MATLAB/Simulink simulation software. The proposed system PV output voltage is as shown in the figure 7.



PV output Voltage Waveform (Fig. 7)

The suggested solution used solar photovoltaic panels to provide the above voltage, which was roughly 80 voltage DC output. The output voltage waveform of the interleaved boost converter which boosts the DC voltage, is depicted in Figure 8.

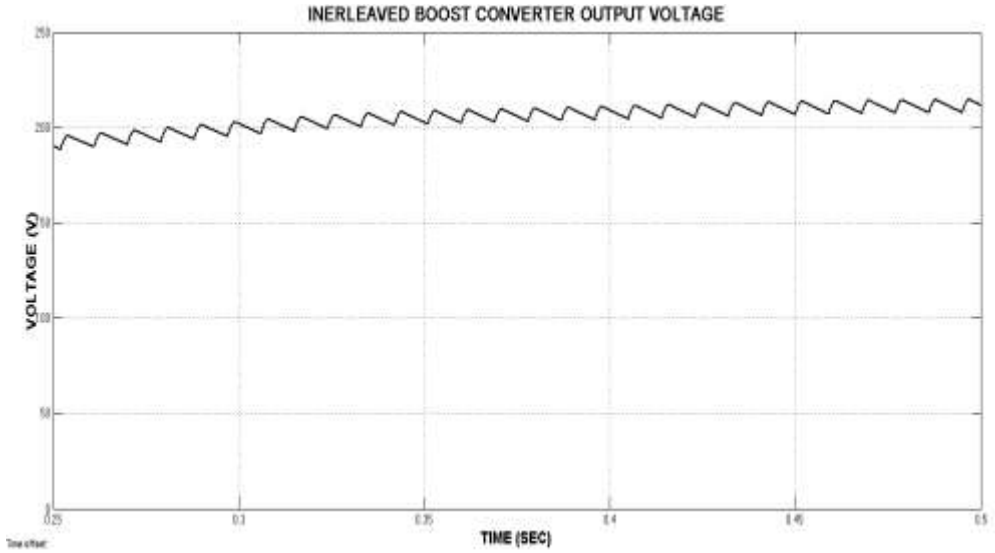


Figure 8. Waveform of the interleaved boost converter output voltage

The proposed MPPT algorithm is depicted in figure 9. The ANFIS algorithm-generated waveform.

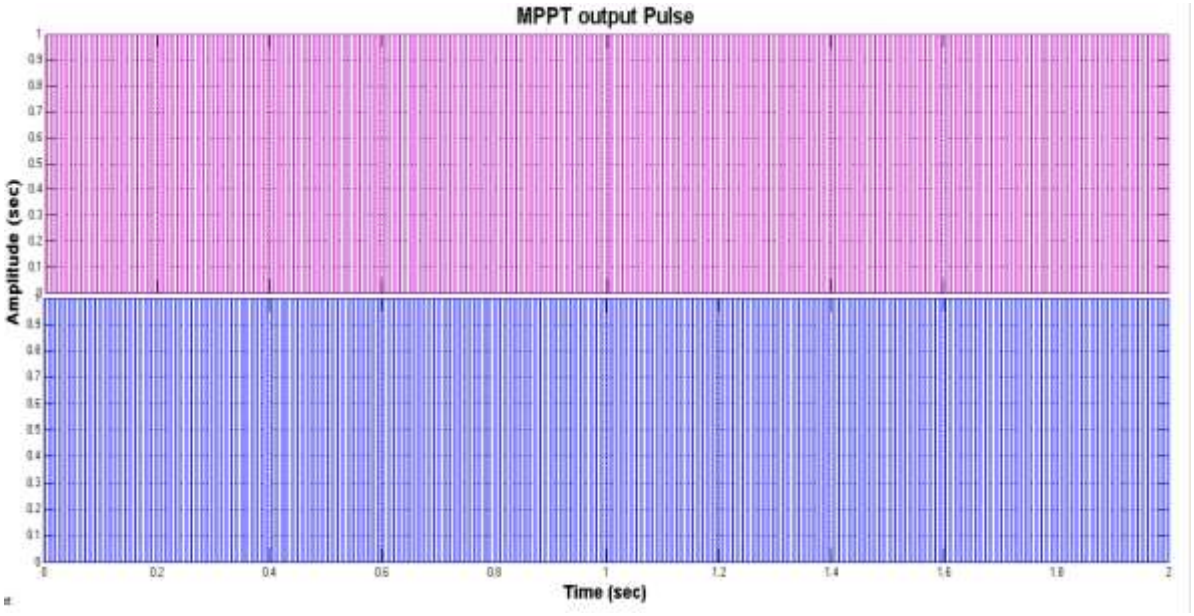


Fig. 9. Proposed ANFIS algorithm output waveform using the MPPT algorithm

The output of the boost converter is delivered into the inverter circuit, which transforms it into AC power. Figure 10 illustrates how much AC voltage there is.

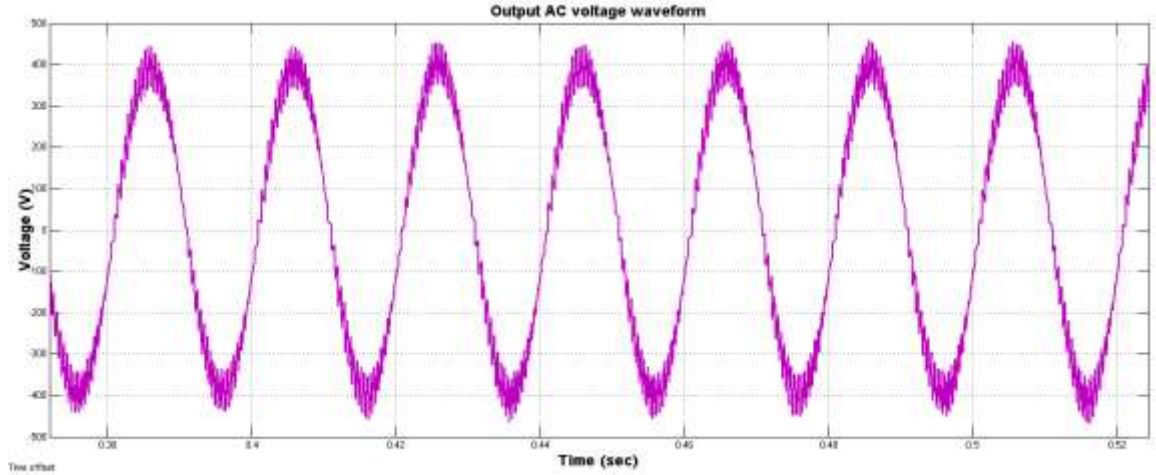


Fig. 10. Waveform of AC output voltage

The conventional P and O algorithm is contrasted with this system's intended use. Figure 11 illustrates the p and O MPPT algorithm output pulse generation for an interleaved boost converter.

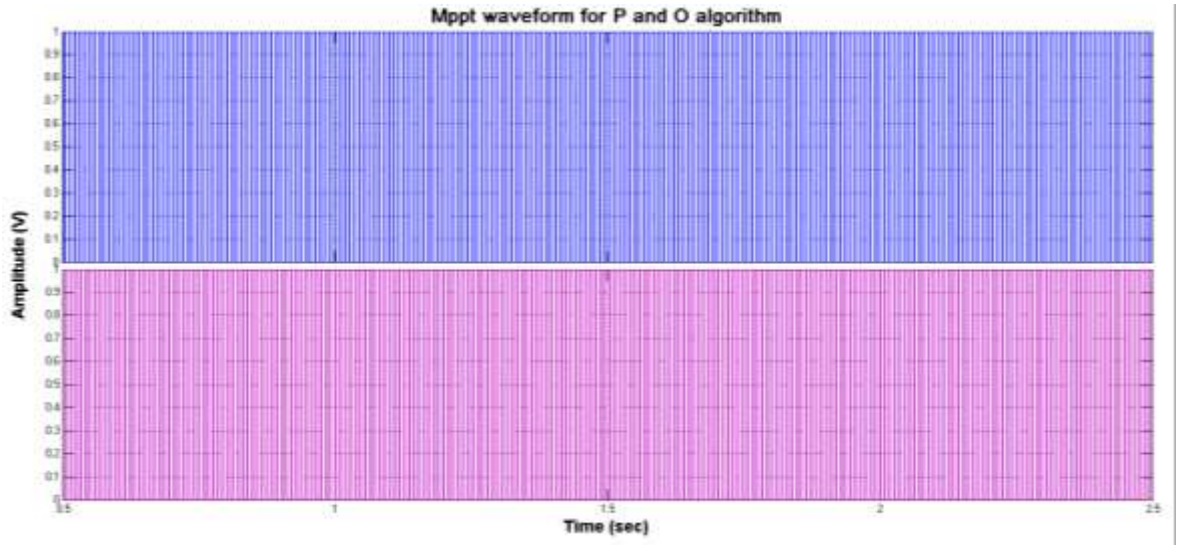


Figure 11. Generation of P and O algorithm output pulses using the MPPT algorithm

The enhanced voltage through this output pulse is considerably lower than the suggested system. Figure 12 depicts the output AC voltage waveform of the current P and O method.

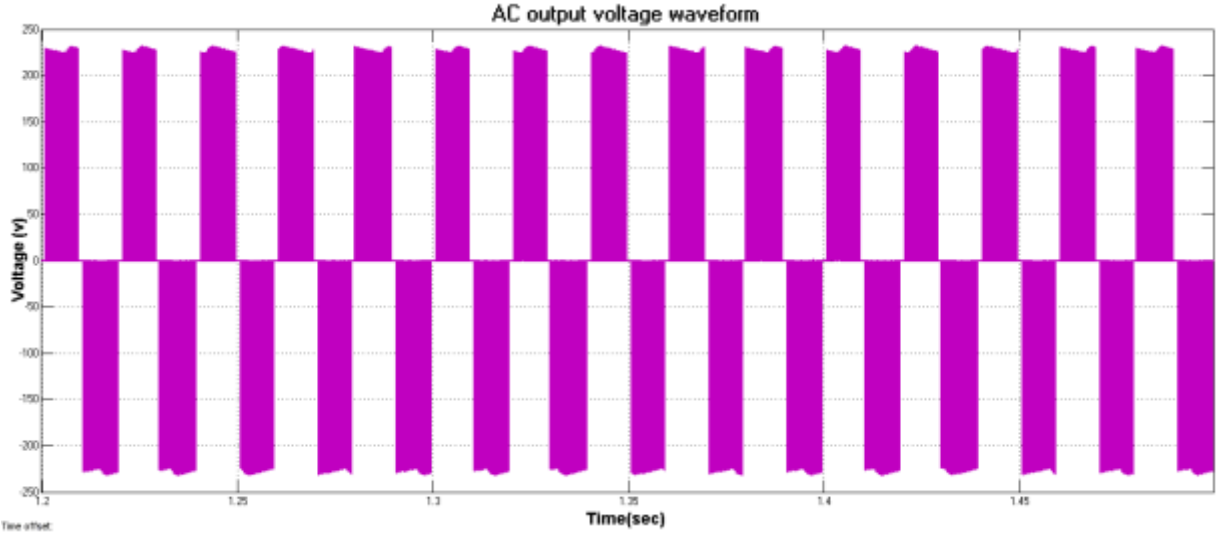


Figure 12. The current system's AC output voltage waveform.

The findings in the following section are drawn from the waveforms produced in this part.

3. Conclusion

For effective solar PV system conversion to link it to either load or grid, a novel technique called ANFIS is proposed. For the difference in voltage output observation, the suggested technique is contrasted with the current P and O algorithm.
This study demonstrates that the ANFIS approach satisfies the criteria for a PV system to use the MPPT algorithm. The advantages of ANFIS as an MPPT approach should be emphasised, and the simulation results show that the ANFIS model may be used more effectively than other models.

4. References

[1] Micro grids connected to the residential grid for energy management utility fuzzy Logic controller employed hybrid electric vehicles Prakash, S. Sakthivel, K. Anitha, S. International Journal of Engineering and Advanced Technology, 2019, 8(6 Special Issue 2), pp. 113–117.

[2] Maximum power extraction by using converters for hybrid renewable energy source fed micro-grid, Sakthivel, K. Jayalakshmi, V. International Journal of Innovative Technology and Exploring Engineering, 2019, 8(8), pp. 2085–2097.

[3] Maximum power extraction by using converters for hybrid renewable energy source fed micro-grid, Sakthivel, K., Jayalakshmi, V. International Journal of Innovative Technology and Exploring Engineering 8(8),pp.2085-2097, 2019.
[4] Modeling and simulation of a grid-tied solar PV system, Sakthivel, K., Jayalakshmi, V., Rajakumari, G. International Journal of Recent Technology and Engineering 7(6), pp. 537 543,2019.
[5] Hybrid renewable power generation scheme for grid integration, Sakthivel, K., Jayalakshmi,V. International Journal of Innovative Technology and Exploring Engineering 8(5s), pp. 630-634, 2019.
[6] Performance analysis of wind and photovoltaic system fed micro grid using fuzzy logic controller, Sakthivel, K., Jayalakshmi, V., Prakash, S. Journal of Advanced Research in Dynamical and Control Systems, 11(1), pp. 686-696, 2019. 11(1), pp. 686-696
[7] Hybrid renewable power generation scheme for grid integration Sakthivel, K. V. Jayalakshmi, International Journal of Innovative Technology and Exploring Engineering, 2019, 8(5s), pp. 630–634
[8] H. Zhu, D. Zhang, B. Zhang, and Z. Zhou, "A non-isolated three-Port DC–DC converter and three-domain control method for PV-battery power systems," IEEE Transactions on Industrial Electronics, vol. 62, pp. 4937-4947, 2015.
[9] E. Babaei and O. Abbasi, "Structure for multi-input multi-output dc–dc boost converter," IET Power Electronics, vol. 9, pp. 9-19, 2016.
[10] Y. Zhao, W. Li, and X. He, "Single-phase improved active clamp coupled-inductor-based converter with extended voltage doubler cell," IEEE Transactions on Power Electronics, vol. 27, pp. 2869-2878, 2012.
[11] J. Zhang, J.-S. Lai, R.-Y. Kim, and W. Yu, "High-power density design of a soft-switching high-power bidirectional dc–dc converter," IEEE Transactions on Power Electronics, vol. 22, pp. 1145-1153, 2007.
[12] J.-B. Baek, W.-I. Choi, and B.-H. Cho, "Digital adaptive frequency modulation for bidirectional DC–DC converter," IEEE Transactions on Industrial Electronics, vol. 60, pp. 5167-5176, 2013.
[13] M. R. Mohammadi and H. Farzanehfard, "A new family of zero-voltage-transition non isolated bidirectional converters with simple auxiliary circuit," IEEE Transactions on Industrial Electronics, vol. 63, pp. 1519-1527, 2016.
[14] P.-H. Tseng, J.-F. Chen, T.-J. Liang, and H.-W. Liang, "A novel high step-up three-port converter, "in Power Electronics and Application Conference and Exposition (PEAC), 2014 International, 2014, pp. 21-25.
[15] Modeling & design of a ANN controller for a BLDC motor on propulsion application for hybrid electric vehicle, Pavan Kumar, K.V.N.S. Prakash, S. International Journal of Recent Technology and Engineering, 2019, 8 (2 Special Issue 11), pp. 3994-4000.
[16] Efficient grid management system with renewable and conventional power sources, Jayavel, R. Rangaswamy, T.R., Prakash, S, 2019, International Journal of Innovative Technology and Exploring Engineering, 8 (6), pp. 287-289