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Z-headspring based on Fuzzy Dialectics to Linked Energy Resources

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ABSTRACT

Background: The proposed work focused on a fuzzy logic controller using Z-headspring inverter. The wind and photovoltaic energy are the most significant of the energy sources today, because of their abundance of sustainability to generate electricity. Based on wind by using power conditioner the converter acts a significant key as a ingredients. While presenting the low voltage, the demanded output voltage impressively can generate in the proposed system. The Z headspring has recently considered for alternative power conversion as both voltage and capabilities. The conventional ones cannot be obtained to improve the voltage and properties from a network utilizes however, this research looking forward for finding new way to improve it. It has single power convention, received AC voltage should be low sinusoidal but this information cannot be provide due to the harmonic content. It just because of highly presented of harmonic content. Higher order harmonics are removed by using of filters. The Fuzzy logic controller for Z headspring inverter is covered in this research.

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INTRODUCTION

A Z-headspring inverter is a type of power inverter, a circuit that converts direct current to alternating current(Robert, L. and Boylestad Louis Nashelsky, 2000) It functions as a buck-boost inverter without making use of DC-DC converter bridge due to its unique circuit topology (Muhammad H. Rashid, 1993).

Types of inverters:

Inverters can be classified by their structure:

1. Single-phase inverter:

This type of inverter consists of two legs or two poles. (A pole is connection of two IGBTs where source of one and drain of other are connected and this common point is taken out).

2. Three-phase inverter:

This type of inverter consists of three legs or poles or four legs (three legs for phases and one for neutral) (Sarmiento, H.G. and E. Estrada, 1996 and Von Jouanne, A., P.N. Enjeti, and B. Banerjee, 1999).

But, inverters are also classified based on the type of input source. And they are,

1. Voltage-source inverter (VSI):

In this type of inverter, a constant voltage source acts as input to the inverter bridge. The constant voltage source is obtained by connecting a large capacitor across the DC source.

2. Current-source inverter (CSI):

In this type of inverter, a constant current source acts as input to the inverter bridge. The constant current source is obtained by connecting a large inductor in series the DC source (Duran-Gomez, J.L., P.N. Enjeti, and A. von Jouanne, 2002).

Disadvantages:

Typical inverters (VSI and CSI) have few disadvantages. They are listed as,

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- Behave in a boost or buck operation only. Thus the obtainable output voltage range is limited, either smaller or greater than the input voltage.
- Vulnerable to EMI noise and the devices gets damaged in either open or short circuit conditions.
- The combined system of DC-DC boost converter and the inverter has lower reliability.
- The main switching device of VSI and CSI are not interchangeable (Y. Kim and S. Sul, 2001 andDuran-Gomez, J.L., P.N. Enjeti, and A. von Jouanne, 2002).

To overcome these disadvantages a new concept was developed in year 2002 by Dr. F.Z. Peng. This involves combination of VSI and CSI to form a cross coupled network of two inductors and two capacitors, known as Impedance Network (Comptun, K.T., 1947).

Operation of Z-headspring inverter:

Normally, three phase inverters have 8 vector states (6 active states and 2 zero states). But ZSI along with these 8 normal vectors has an additional state known as the shoot through state, during which the switches of one leg are short circuited. In this state, energy is stored in the impedance network and when the inverter is in its active state, the stored energy is transferred to the load, thus providing boost operation. Whereas, this shoot through state is prohibited in VSI.

To achieve the buck-boost facility in ZSI, required Pulse-width modulation is as shown in figure. The normal Sinusoidal PWM (SPWM) is generated by comparing carrier triangular wave with reference sine wave. For shoot through pulses, the carrier wave is compared with two complementary DC reference levels. These pulses are added in the SPWM, highlighted in figure. ZSI has two control freedoms: modulation index of the reference wave which is the ratio of amplitude of reference wave to amplitude of carrier wave and shoot through duty ratio which can be controlled by DC level (Robert, L. and Boylestad Louis Nashelsky, 2000). Figure 1 shows a basic inverter.

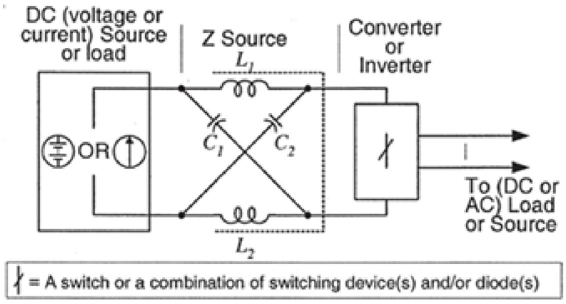

Fig. 1: Basic Inverter.

Hybrid Energy Resources:

Europe is large society and the rate of electrification has not kept pace with the expanding population, urbanization and industrialization and has resulted in the increasing deficit between demand and supply of electricity. This has not only resulted in under electrification but also put heavy pressure on the governments to keep pace with demand for electricity. People not served by the power grid have to rely on fossil fuels like kerosene and diesel for their energy needs and also incur heavy recurring expenditure for the poor people in rural areas. Wherever the rural areas have been brought under power grid the erratic and unreliable power supply has not helped the farmers and the need for an uninterrupted power supply especially during the critical farming period has been a major area of concern. The development of wind power in Italy began in the 1990s, and has significantly increased in the last few years. Although a relative newcomer to the wind industry compared with Denmark or the United States, Italy has the fifth largest installed wind power capacity in the world. In 2009-10 Italy's growth rate was highest among the other top four countries. Figure 2 shows the diagram of wind solar hybrid energy.

Pwm Techniques:

Pulse-width modulation (PWM), or pulse-duration modulation (PDM), is a modulation technique that controls the width of the pulse, formally the pulse duration, based on modulator signal information. Although this modulation technique can be used to encode information for transmission, its main use is to allow the control of the power supplied to electrical devices, especially to inertial loads such as motors. In addition, PWM is one of the two principal algorithms used in photovoltaic solar battery chargers, the other being MPPT.

The average value of voltage (and current) fed to the load is controlled by turning the switch between supply and load on and off at a fast pace. The longer the switch is on compared to the off periods, the higher the power supplied to the load.

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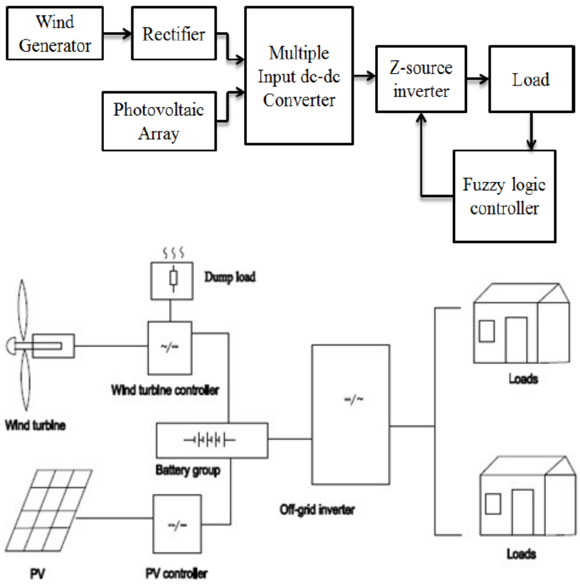

Fig. 2: Diagram of Wind Solar Hybrid Energy.

The PWM switching frequency has to be much higher than what would affect the load (the device that uses the power), which is to say that the resultant waveform perceived by the load must be as smooth as possible. Typically switching has to be done several times a minute in an electric stove, 120 Hz in a lamp dimmer, from few kilohertz (kHz) to tens of kHz for a motor drive and well into the tens or hundreds of kHz in audio amplifiers and computer power supplies.

The term duty cycle describes the proportion of 'on' time to the regular interval or 'period' of time; a low duty cycle corresponds to low power, because the power is off for most of the time. Duty cycle is expressed in percent, 100% being fully on.

The main advantage of PWM is that power loss in the switching devices is very low. When a switch is off there is practically no current, and when it is on and power is being transferred to the load, there is almost no voltage drop across the switch. Power loss, being the product of voltage and current, is thus in both cases close to zero. PWM also works well with digital controls, which, because of their on/off nature, can easily set the needed duty cycle.

PWM has also been used in certain communication systems where its duty cycle has been used to convey information over a communications channel. Figure 3 illustrates of an example of PWM in an AC motor drive and Figure 4 describes PMW from boost control.

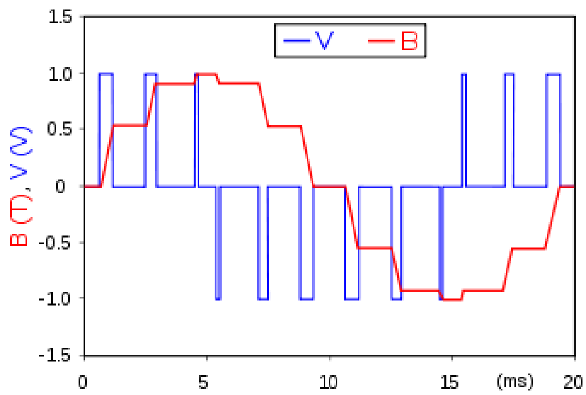

Fig. 3: an Example of PWM in an AC Motor Drive.

Fuzzy control system:

A fuzzy control system is a control system based on fuzzy logic—a mathematical system that analyzes analog input values in terms of logical variables that take on continuous values between 0 and 1, in contrast to classical or digital logic, which operates on discrete values of either 1 or 0 (true or false, respectively). Fuzzy logic is widely used in machine control. The term "fuzzy" refers to the fact that the logic involved can deal with concepts that cannot be expressed as "true" or "false" but rather as "partially true". Although alternative approaches such as genetic algorithms and neural networks can perform just as well as fuzzy logic in many cases, fuzzy logic has the advantage that the solution to the problem can be cast in terms that human operators can understand, so that their experience can be used in the design of the controller. This makes it easier to mechanize tasks that are already successfully performed by humans.

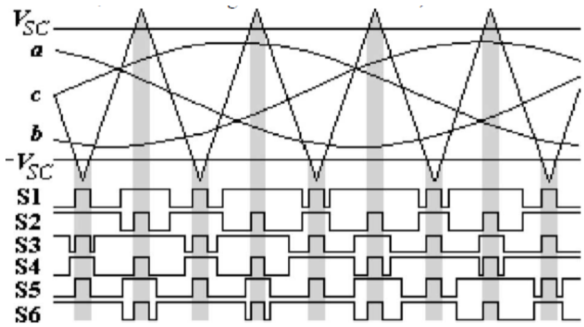

Fig. 4: PMW from Boost Control.

Fuzzy control in detail:

Fuzzy controllers are very simple conceptually. They consist of an input stage, a processing stage, and an output stage. The input stage maps sensor or other inputs, such as switches, thumbwheels, and so on, to the appropriate membership functions and truth values. The processing stage invokes each appropriate rule and generates a result for each, then combines the results of the rules. Finally, the output stage converts the combined result back into a specific control output value.

The most common shape of membership functions is triangular, although trapezoidal and bell curves are also used, but the shape is generally less important than the number of curves and their placement. From three to seven curves are generally appropriate to cover the required range of an input value, or the "universe of discourse" in fuzzy jargon.

As discussed earlier, the processing stage is based on a collection of logic rules in the form of IF-THEN statements, where the IF part is called the "antecedent" and the THEN part is called the "consequent". Typical fuzzy control systems have dozens of rules. Figure 5 represents structures of fuzzy logic system.

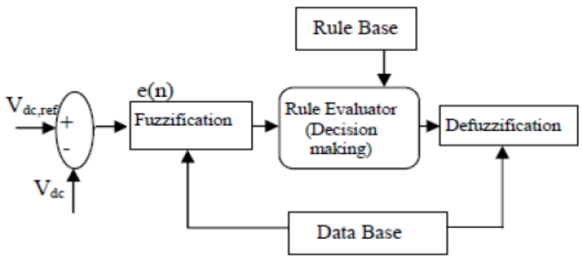

Fig. 5: structures of fuzzy logic system.

RESULTS AND DISCUSSION

After getting the simulation and receive the results we found that the wind speed variations and rapidly changing of the solar irradiance are measured in different times. The impedance network elements are designed for simulation. The switching frequency is 10 kHz and the fundamental frequency is 50Hz. Figure 6 shows output voltage in volts.

The output is dependent on the voltage across in inverter. Generally, the AC voltage output is always higher that the DC voltage input. It just because of the duty cycle produced. Figure 8 shows the active and reactive power flow and power waveform. The results showed that the active power of z-headspring is about 6 KW and the reactive power is about 5 KVAR. The THD (total harmonic distortion) calculated using FFT analysis tool that provide in Simulink model. The nominal THD value is less than 7%. The simulation results are shown for inverter by the help of RL loads. If we use PI controller, the THD result is 14% and the harmonic distortion is higher than PI controller. Therefore, we can conclude that one of the best suitable ways to reduce the THD value is to use fuzzy logic controller.

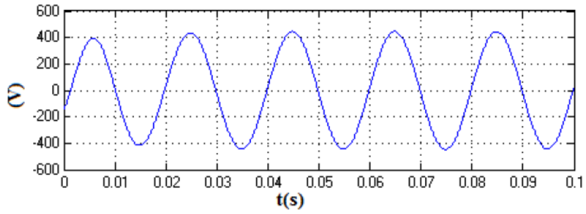

Fig. 6: Output Voltage in Volts.

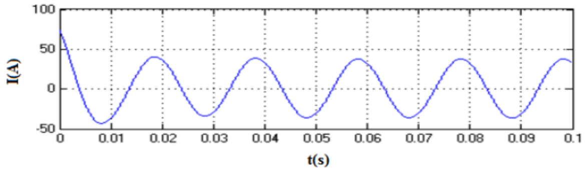

Fig. 7: Output Voltage in Amps.

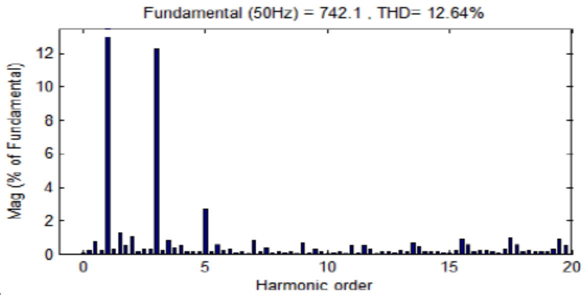

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Fig. 8 THD Waveform Using PI Controller.

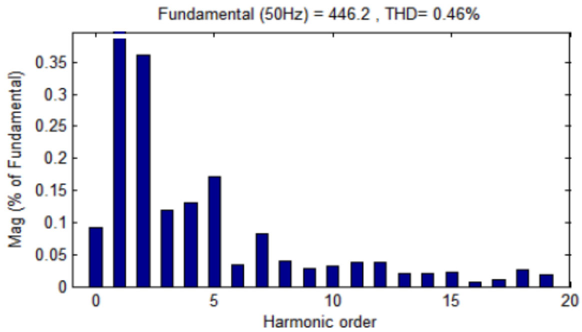

Fig. 9: THD Waveform Using Fuzzy Logic Controller.

The harmonic analysis on the voltage output is obtained. The total harmonic distortion by using fuzzy logic controller was already calculated. The value obtained as 0.56%. As it is clear in the above figure, THD is reduced to 0.56% than congenital inverter.

Conclusion:

This research paper evaluated wind and PV system among the multiple input DC converter and Z headspring inverter by the help of fuzzy logic controller proposed and simulated waveforms. The proposed wind generator and PV system to generate maximum power energy from the wind and solar energy sources. In this work, multiple input of DC converter are applied to the wind generator and PV system as well to get the DC voltage. The DC voltage is fed into the z headspring inverters has both buck and boost voltage capabilities to collect the voltage level of 550 V AC. This method has used to decrease the harmonics and with less distortion, generate voltage waveform.

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