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Fuzzy Grammar Based Hybrid Split-Capacitors and Split Inductors Applied In Positive Output Luo-Converters

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ABSTRACT

The positive output super lift Luo converter is a recently developed superior DC-DC converter. The object of this paper is to plan and examine a positive output super lift Luo converter using fuzzy system. Advantage of the proposed converter are heftiness around the operating point, high-quality presentation of transient responses under varying loading conditions and/or input voltage, and invariant active performance in the presence of varying operating conditions. Luo converter is the developed converter derived from the buck boost converter. A computer simulation using matlab/simulink confirms the predicted results.

Keywords: DC-DC Converter, Voltage Transfer Gain, Fuzzy Logic Controller.

I. INTRODUCTION

Renewable energy sources have experienced a rapid development in recent years. These systems employ with micro sources like PV, fuel cells etc. PV cells to produce high voltage but there exist severe problems like shadowing effects, short circuit which significantly reduces its efficiency. In order to overcome such unfavorable conditions this type of micro source energy is applied to the high step up converter to produce high voltage and fulfill the demands.

DC-DC switching converters are a traditional benchmark for testing nonlinear controllers, due to their inherent nonlinear characteristics. After the pioneering studies of Middle rock [1], a great deal of research has been directed at developing techniques for averaged modeling of different classes of switching converters [2] and for an automatic generation of the averaged models [3]. The motivation of such studies was the selection of continuous models as simple as possible, but adequate to capture all the main features of the switching converters in terms of stability, dynamic characteristics and effectiveness for designing closed loop regulators. A large number of possible nonlinear controllers have been proposed. The DC-DC luo converter can convert the source voltage into a higher output voltage with higher efficiency, high power density and simple structure [3]. Proportional Integral (PI) controller has been implemented for the proposed DC-DC converter. PI control techniques offer stability, large line and load variation robustness, good dynamic response. PI control is chosen to ensure fast dynamic response for line side and load side disturbances with output voltage regulation [4]-[6]. However, these controllers are very sensitive to circuit parameter variations, change in operating region, line and load voltage disturbances. A fuzzy logic controller (FLC) and sliding mode controller (SMC) for the conventional DC-DC converters has been reported in [7-8]. However, the FLC for all the converters has produced small output voltage start-up overshoots, high overshoots during the dynamic conditions and high output ripple voltage compared to PI controller [9]. The FLC based PID controller for the buck DC-DC converter has been reported [10].

II. METHODS AND MATERIAL

A. Analysis of Luo Converter

The circuit diagram of the Buck-Boost output Luo converter is shown in Fig. 1. In the circuit, S is the power switch and D is the freewheeling diode

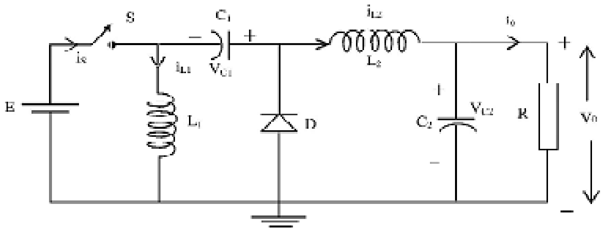

Fig 1: Luo converter

The energy storage passive elements are inductors. L1, L2 and capacitors C1, C2, R is the load resistance. To analyse the operation of the Luo converter, the circuit can be divided into two modes. When the switch is ON, the inductor L1is charged by the supply voltage E. At the same time, the inductor L2 absorbs the energy from source and the capacitor C1. The load is supplied by the capacitor C2. The equivalent circuit of Luo converter in mode 1 operation is shown in (a). During switch is in OFF state, and hence, the current is drawn from the source becomes zero, as shown in (b). Current iL1 flows through the freewheeling diode to charge the capacitor C1. Current iL2flows through C2 –R circuit and the freewheeling diode D to keep itself continuous. If adding additional filter components like inductor and capacitor to reduce the harmonic levels of the output voltage. For closed loop simulation we go for state space transfer function. During MOSFET-ON

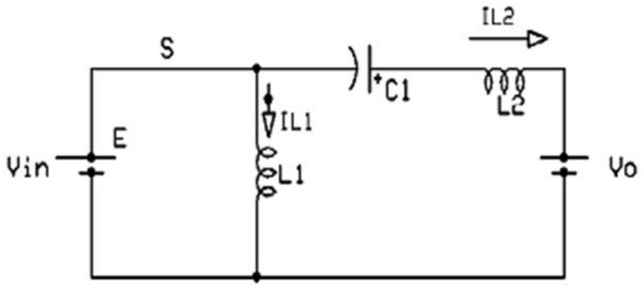

Fig 2: Luo converter with MOSFET ON condition

$$-V_{in}+L1\frac{dI_{L1}}{dt}=0\Rightarrow\frac{dI_{L1}}{dt}=\frac{V_{in}}{L1}\quad\ldots\ldots(1)$$

$$V_{C2}+L2\frac{dI_{L2}}{dt}=0\Rightarrow\frac{dI_{L2}}{dt}=-\frac{V_{C2}}{L2}\quad\ldots\ldots(2)$$

$$-I_{L1}+C1\frac{dV_{C1}}{dt}=0\Rightarrow\frac{dV_{C1}}{dt}=\frac{I_{L1}}{C1}\quad\ldots\ldots(3)$$

$$-I_{L1}+C2\frac{dV_{C2}}{dt}-I_{L2}+\frac{V_{C2}}{R}=0\Rightarrow\frac{dV_{C2}}{dt}=-\frac{V_{C2}}{RC2}+\frac{I_{L1}}{C2}+\frac{I_{L2}}{C2}\ldots\quad(4)$$

During MOSFET-OFF,

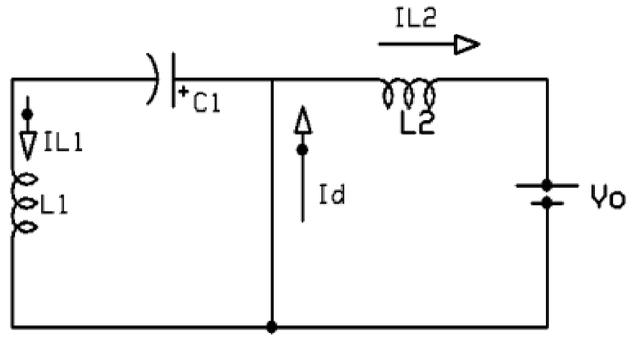

Fig 3: Luo converter with MOSFET OFF condition

The actual armature voltage of a dc motor is compared with reference voltage and error so obtained is processed by PI controller. The main function of PI controller is to reduce the peak overshoot and make steady state error zero. With the transfer function mentioned above, by using pole placement technique, the PI controller is obtained as

$$C=46.572*\frac{2.42*10^{-6}S^{2}+0.0033S+1}{1.7*10^{-7}S^{2}+S}\quad\ldots(5)$$

B. Fuzzy Logic Controller

Fuzzy logic system is an intelligent system which is easy to understand, simple to design and better than using the other type of controller. In Fuzzy logic controller, better tuning of fuzzy will provide better output. This logic allows modeling of complex systems by combining alternative way of thinking using a higher level of abstraction. The variables of fuzzy logic are described for the control algorithm which influences the system variables and a rule table.

The gain is defined as a division between the input voltage and average output voltage value. The block diagram of fuzzy logic controller (FLC) is shown in fig.4. It consists of three main blocks: fuzzification, inference engine and defuzzification. The two FLC input variables are the error E and change in error ΔE. Depending on membership functions and the rules FLC operates. Mandeni type fuzzy logic scheme is used here.

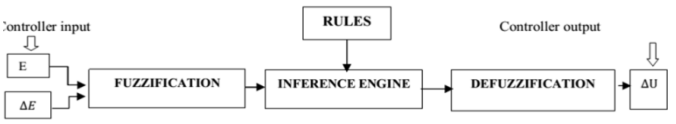

Figure 4: Block diagram of FLC

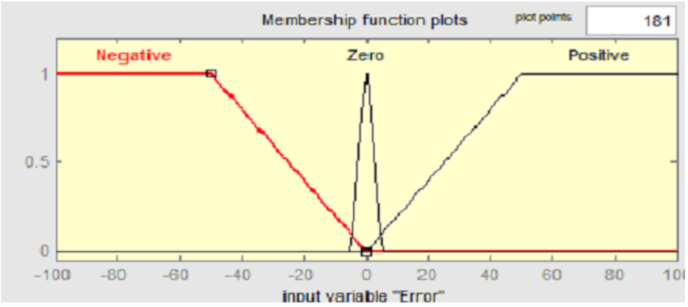

Figure 5: Membership function for error

There are three membership functions for the input variable error. Fig. 5 shows the membership functions of input variable error.

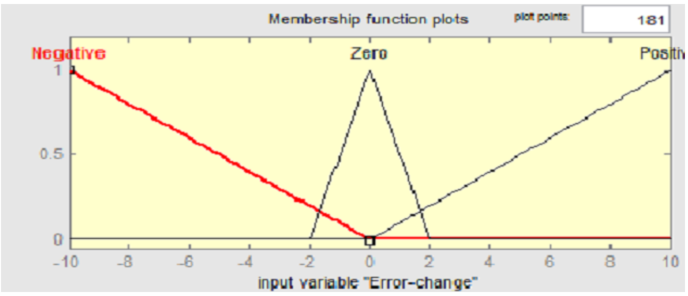

Figure 6: Membership function for delta error

There are three membership functions for the input variable delta error. Fig. 6 shows the membership functions of input variable delta error.

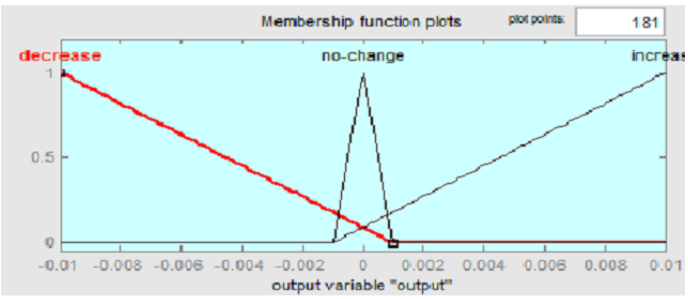

Figure 7: Plot of membership function for output

There are three membership functions for the output variable. Fig. 7 shows the membership functions of output variable.

Five rules are used for obtaining fuzzy controlled output. They are:

1. If (error is negative) then (output is decrease)
2. If (error is zero) and (output is negative) then (output is decrease)
3. If (error is zero) and (output is zero) then (output is no-change)
4. If (error is zero) and (output is positive) then (output is increases)
5. If (error is positive) then (output is increases)

C. Positive Luo Converter

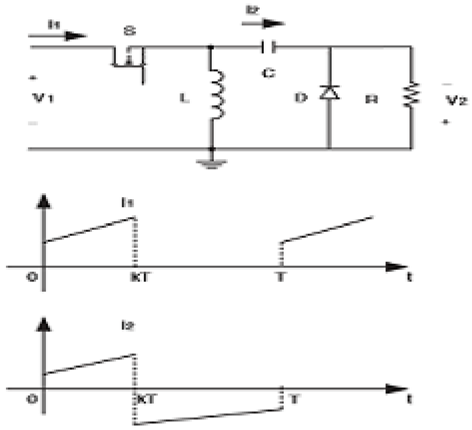

Figure 8: Positive Luo converter

The circuit diagram of the positive Luo-pump and some current and voltage waveforms are shown in Fig7. Voltage Lift (VL) technique has been widely used in electronic circuit design. Because of the effect of parasitic elements, the output voltage and power transfer efficiency of all DC-DC converters is restricted. Added, voltage lift technique still has its disadvantages, such as the output voltage increases in arithmetic progression. Along with the development of conversion technique, Super-Lift (SL) technique has shown a more powerful ability than voltage lift technique. Based on the super-lift technique, Super-Lift LuoConverters are widely used to produce high output voltages; Super-Lift Luo-Converter has several advantages. Firstly, it has a very high voltage transfer gain. The output voltage can be increased in geometric progression. Secondly, it has a high efficiency and a high power density. In addition, Super-Lift Luo Converter has the ability to reduce ripple voltage and current. This converter consists of V_{in}, capacitors C1 and C2, inductor L, power switch IGBT and freewheel diodes D_1 and D_2. Also, it has a voltage lift circuit (VLC). VLC consists of diode D_1 and capacitor C1.The circuit diagram of the POSLLC is shown in Fig. 7 Switch S and diode D are alternately on and off. Usually, this pump works in continuous operation mode, inductor current is continuous in this case. The output terminal voltage and current is usually positive.

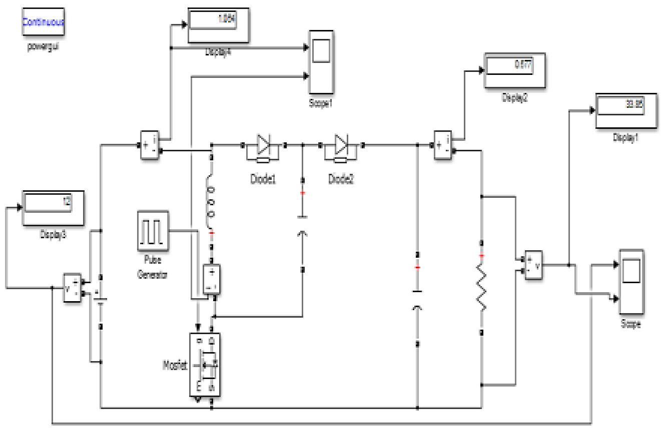

Figure 9 : Simulink Model for Luo converter

D. Fuzzy Based Luo Converter

The output voltage of the Luo converter is compared with reference voltage by the comparator and the output of converter is error signal which is fed to the Fuzzy controller along with the change in error signal. The output of controller is dc signal which is superimposed on a saw tooth signal to produce a switching signal to the converter as shown in Figure 9

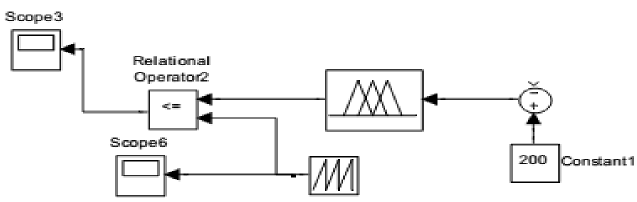

Figure 10 : Fuzzy Luo converter

III. SIMULATION AND RESULTS

The simulation has been performed on the positive output Fuzzy based Luo converter for pv system controller circuit with parameters listed in Table1.

Table 1: Test Parameters

Fuel cell		
	DC voltage	100
	DC current	50A
Luo Converter		
	R_1, L_1	1Ω, 20mH
	R_2, C_1	1Ω, 20uF
	R_3, L_2	1Ω, 20mH
	R_4, C_2	1Ω, 2000uF

With the above test parameters and reference voltage of 200 V dc, the fig shows the output speed of converter fed dc drive using PI & fuzzy controller. The wave form is free from fluctuations, but settling time is little bit more; the output is following the input. The positive output super lift luo converter is designed and simulated using MATLAB/Simulink and the output voltage from converter is shown in Fig. 10 and 11.

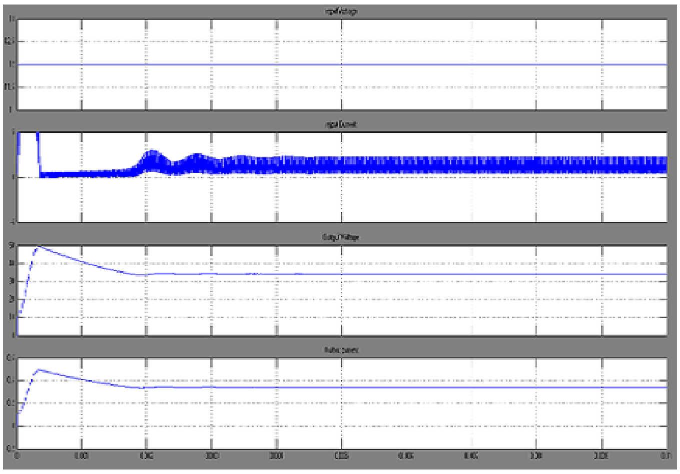

Figure 11 : Simulation results

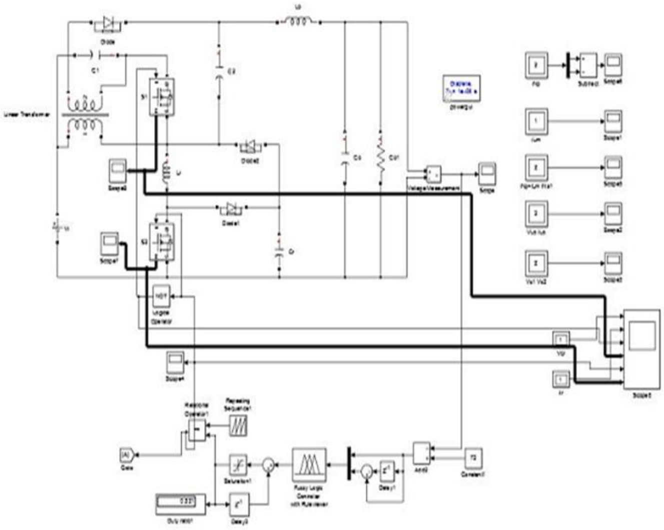

Figure 12 : Simulation Model

The fig.10 shows the output voltage obtained from converter with FLC and Luo converter. Output from FLC gives better performance when compared to converter with PIC. Output from the fuzzy controller will have reduction in settling time, reduction in output voltage overshoot and ripples, however output from Luo will have a vice versa result. The Super lift Luo converter was built and tested at 230V. The Experimental setup of the POSLLC is shown in Fig.10. The circuit parameters are R0=60Ω; L0=150μH; C0=1000μF,; L=100μH; Li=8.0mH; Cin=0.94μF. He ATMEL 89C2051 based control circuit is shown in Fig.

4.g. Atmel microcontroller 89C2051 was used to generate driving pulses for the MOSFET switches. They are amplified using the driver IR2110. The gate signal is connected to port pin P1.0. The experimental waveform of the output voltage is shown in Fig.10

IV. CONCLUSION

The positive output of fuzzy based luo converter performs the voltage conversion from positive source voltage to positive load voltage. The application of positive output triple lift luo converter in solar pv system produces voltages increasing in geometric progression. It produces output voltage of 220V for the input voltage of 40V from solar pv system. The converter have proved to be Robustness around the operating point, Good dynamic performance in the presence of input voltage variations and Invariant dynamic performance in presence of varying operating conditions.

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VI. BIOGRAPHIES

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