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Comparison of Cuckoo Search Algorithm and Perturb & Observe Algorithm in Positive Elementary Superlift Luo Converter for Motor Drive Application

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Abstract

Positive Output Elementary Super-lift Luo Converter is the DC-DC Converter, has the voltage lifting techniques. This plays vital role in designing electronic circuit. The voltage output variation is in geometric progression. To get static and dynamic control cuckoo search algorithm is used. Solar PV is used to reduce the effects of parasitic components which has an impact in output voltage and power transfer. The output from the converter is used for Motor drive application.

Keywords: Super-lift Luo Converter, Photovoltaic, Cuckoo Search, Voltage Lifting Techniques, Parasitic Elements. Drive, Motor

Introduction

DC-DC converters plays vital role in every day application for satisfying domestic, business, agriculture and in industrial application. Advancement in power system requires equipment in miniature size, highly reliable with high quality in terms of efficiency and less cost. Nowadays linear controllers are replaced by DC-DC converters [1] - [7]. Recent work was done in this type of converter for voltage lift-techniques in many applications like EV, PV, Traction and fuel cell.

Main three types of DC-DC converters [8] &[9]are converters without transformer, resonant type and isolated type. Transformer less converters were classified into buck, boost, buck-boost. The above converters have demerits in voltage gain and output power with high Switching losses. Later resonant converters were introduced with less switching losses and harmonic in output. For wide voltage regulation the Resonant Converter [10] is not suitable. Isolated converters have restricted gain as duty cycle approaches unity due to the presence of parasitic elements. So in order to reduce parasitic elements, super- lift Luo Converter [12]-[15] was designed. This converter has voltage lifting technology due to the presence of Capacitor and Inductor and thereby increases the gain and power.

Three types of voltage lifting techniques were self-lift, super-lift, ultra-lift converters. The proposed (POSLC) [16] & [17]is to increases the gain and p ower using cuckoo search algorithm to drive BLDC motor in steady state conditions with reduced ripples. Figure.1 gives the block diagram of proposed POSLC.

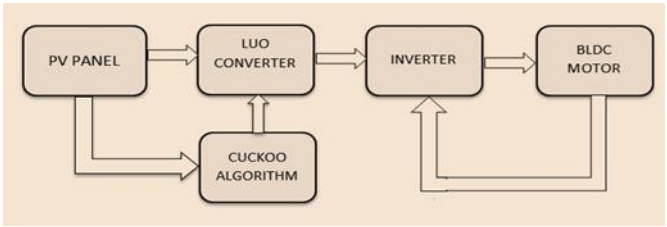


Figure 1. Proposed Block diagram

PHOTO VOLTAIC SYSTEM

Photo Voltaic systems uses cells to convert solar rays into electricity [19]. PV array consists of solar cells arranged either in series or in parallel. This generates DC output depending upon solar irradiance and temperature. Figure 2 depicts equivalent circuit of solar cell.

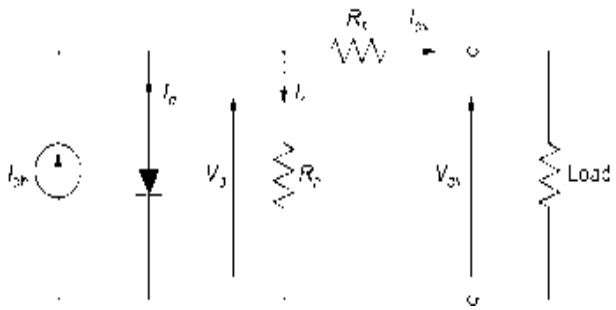


Figure 2. Solar Cell Equivalent circuit

The Solar output voltage is given in equation (1)

$$V = Vsh - IRs - - - - - (1)$$

The solar output current is given in equation (2)

$$I = I_L - I_D \ - - - - - - (2)$$

The obtained current is directly proportional to sun radiation temperature Photo Voltaic array [11] is designed in Simulink MATLAB function.

POSITIVE OUTPUT ELEMENTARY SUPER-LIFT LUO CONVERTER

The proposed converters possess high-voltage transfer gain, efficiency with reduced ripple in voltage and current [18]. This converter produces the positive load voltage.

The circuit consist of a switch, ‘n’ number of inductors, ‘2n’number of capacitors and (3n-1) number of diodes. The proposed POSLC representation is as in Figure 3

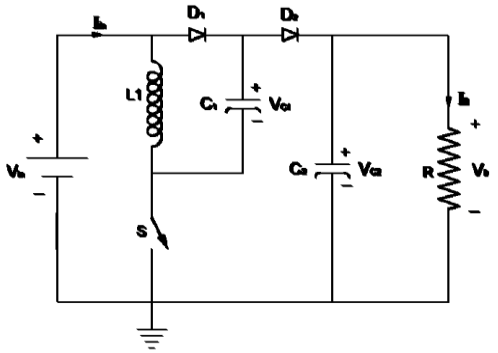


Figure3. Circuit representation of POSLC

OPERATING PRINCIPLE

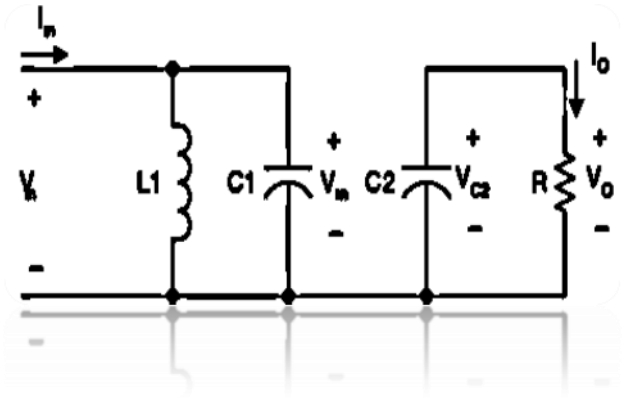


Figure 4. Equivalent Circuit in ON state

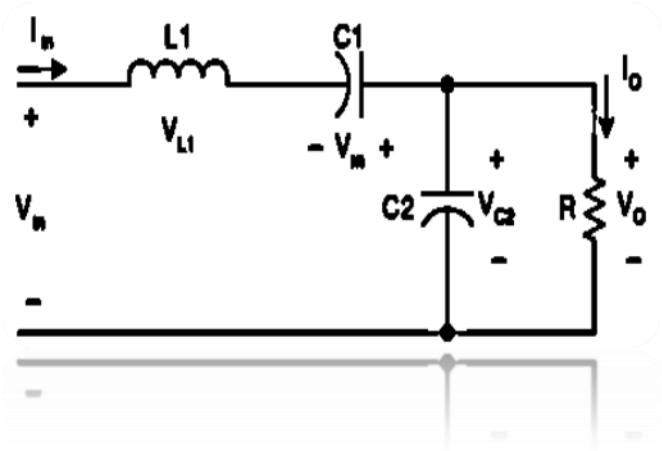


Figure: 5. Equivalent circuit in OFF state

Equivalent circuit during ON and OFF period is shown in Fi ure 4 and Figure 5. The capacitor C1 charges to input voltage Vin. The current through inductor L_1 increase with input voltage in ON state DT and decreases with voltage (Vo-2Vin) in OFF state (1-D) T is given in equation (3). Hence,

$$\frac{Vo}{Vin} = \frac{2-D}{1-D} \quad ---------(3)$$

MPPT TECNIQUES

To achieve maximum power under all conditions MPPT is used commonly with wind turbines and solar systems.

Cuckoo Search (CS) [20] is advanced optimization technique using meta heuristic (MH) approach. To validate the proposed algorithm, various cases of partial shading is used.

Cuckoos birds like ani are fascinating birds with beautiful sounds and forceful reproduction strategy. These type of birds lay eggs in communal nests and others' eggs can be removed to boost the probability of hatching their own eggs.

Initially, cuckoo female chooses a group of host species with similar nest sites. Cuckoo birds starts seeking in for the best nest, it is an key role for cuckoo's reproduction.

Searching nest is similar to the process of searching food. Using levy's flight model the walks and directions were identified and mathematical modelling is carriedout.

Recent approach by Reynolds and Frey shows that the fruit flies search out their landscape uses a string of straight flight paths with sudden 900 turn leading to a levy's flight. Figure 6 shows the Levy's style.

This concept is used in finding optimization for various problems. Levy's is a unplanned walk, in this steps have a probability distribution and it is represented in step lengths.

In Cuckoo Search, length of step is taken from levy's distribution based on power law. Random walk process is followed in Steps with a heavy tail.

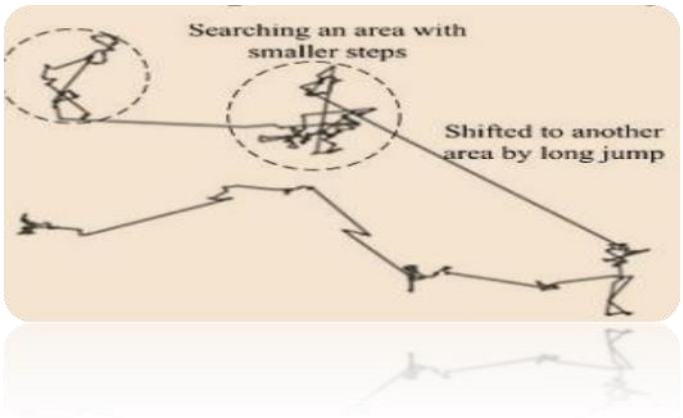


Figure 6. Levy's Flight

In Lévy flight the step length will follow the Lévy distribution, permitting Cuckoo Search to perform "long jump" among small flights. The "long jump" necessary feature, that permits the CS to prevent LMP and shortens tracking duration needed to reach GMPP.

Figure 7 depicts the Flow diagram of cuckoo search algorithm

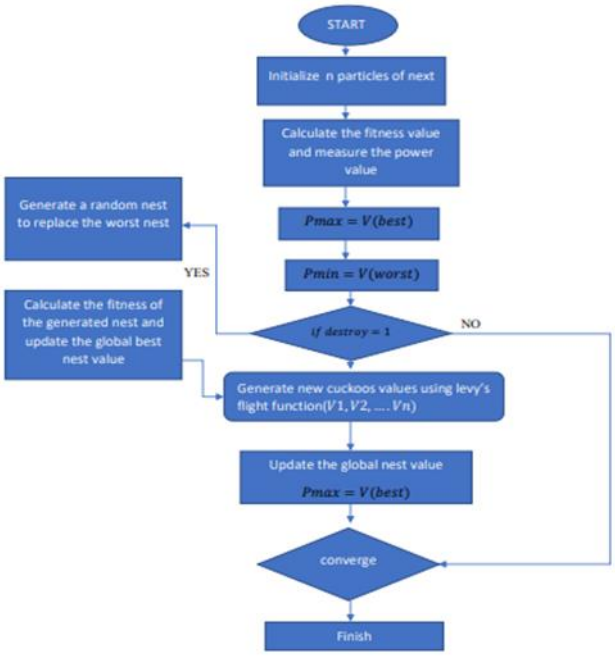


Figure 7. Flow diagram of cuckoo search algorithm

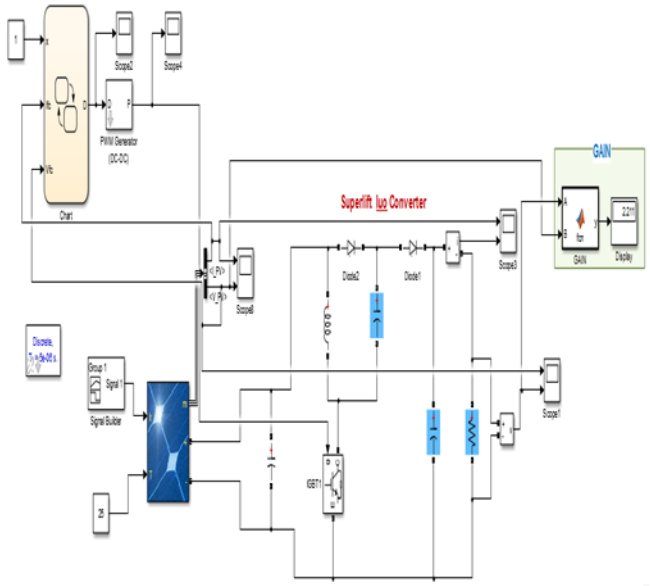
BRUSHLESS DC MOTOR

A Brushless DC Motor does not have brushes. BLDC motor is an electronically commuted Motor.

These types of Motor produce a large amount of torque over a wide speed range. Here to control the speed and Torque, Voltage Sources Inverter is(VSI) used. Position of rotor is sensed using Hall effect sensor.

SIMULATION MODEL

7. 1 SIMULATION MODEL USING P&O METHOD



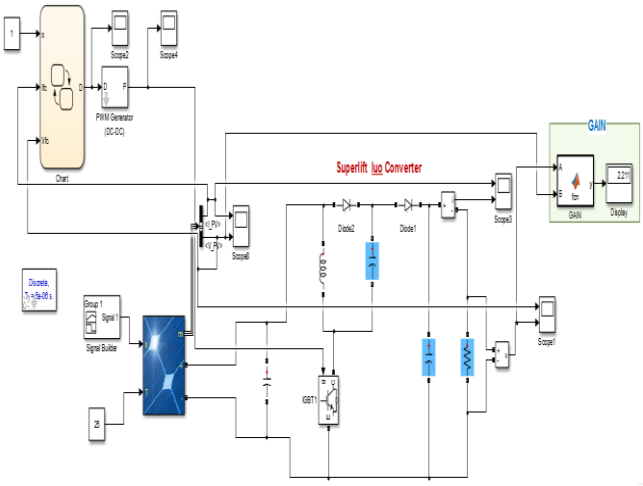


Figure 8 Simulation Model Using P&O Method

7.2 SIMULATION MODEL USING CUCKOO SEARCH ALGORITHM METHOD

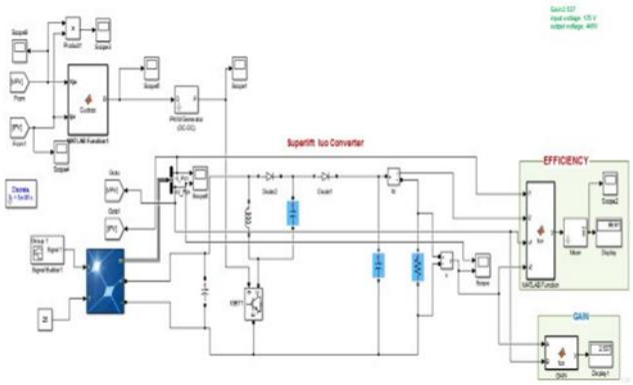


Figure 9. Simulation Model Using Cuckoo Search Algorithm Method

7. 3 SIMULATION OF BLDC MOTORDRIVE USING CUCKOO SEARCH ALGORITHM

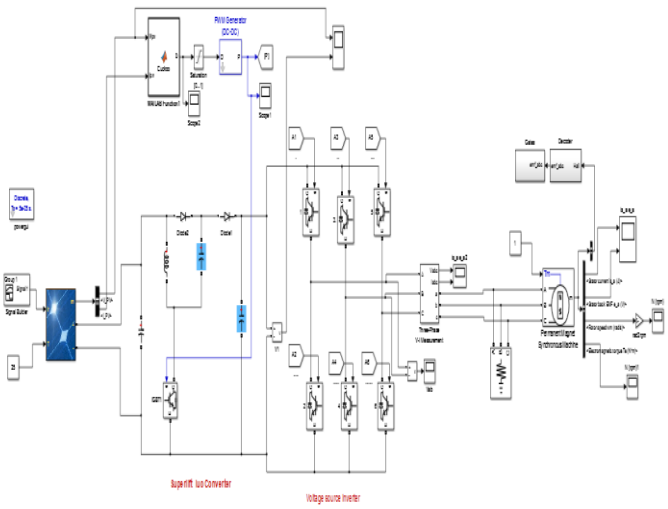


Figure 10. Simulation of BLDC Motor drive using Cuckoo Search Algorithm

Figure 10. depicts the Simulation diagram of BLDC Motor drive using Cuckoo Search Algorithm using Positive Output Elementary Super lift Luo converter.

In comparison with P&O algorithm cuckoo search algorithm is the best method to optimize the static and dynamic characteristics with load and obtain accurate duty cycle values with less ripple voltage and current.

Table 1 and Table 2 shows the specification and designed parameters values of POSLC

TABULATION

Table 1: Specification of POSLC

PARAMETERS	**SYSMBOLS**	**VALUES**
APPLIED VOLTAGE	V_{in}	185 V
VOLTAGE OBTAINED	V_O	540 V
DUTY RATIO	D	0.48
SWITCHING FREQUENCY	F_s	1500Hz

Table 2: Design values of (POSLC)

PARAMETER	**SYMBOLS**	**VALUE**
INDUCTANCE	L	0.01Mh
CAPACITOR	C1 C2	100e-6 F 150e-6 F

Table 3: Specification of BLDC Motor

PARAMETRS	**SYSMBOLS**	**VALUES**
AC VOLTAGE	Trapezoidal wave	350 V
SPEED	N	2750 Rpm
CURRENT	I	1.8 A

Table 4. shows the Quantitative analysis of Cuckoo search & Perturb and Observe Method.

For same applied input voltage, the output voltage and gain obtained in Cuckoo search is higher than P&O algorithm.

Table 4. Quantitative comparison of Cuckoo search & Perturb and Observe Method

CUCKOO SEARCH ALGORITHM	PERTURB & OBSERVE ALGORITHM
Global Search algorithm	Local Search algorithm
Meta Heuristic	Heuristic
Input Voltage:185	Input Voltage:185
Output Voltage:540	Output Voltage:320
Gain:2.537	Gain:2.211

SIMULATION RESULT

Figure 11 (a), (b), (c) and (d) shows the simulation response using Perturb & Observe algorithm and Cuckoo Search algorithm

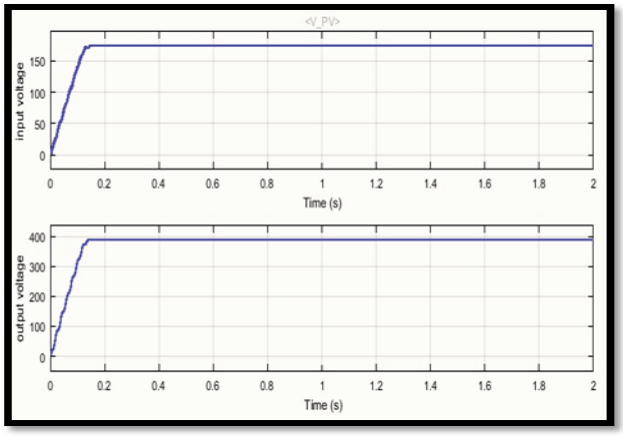
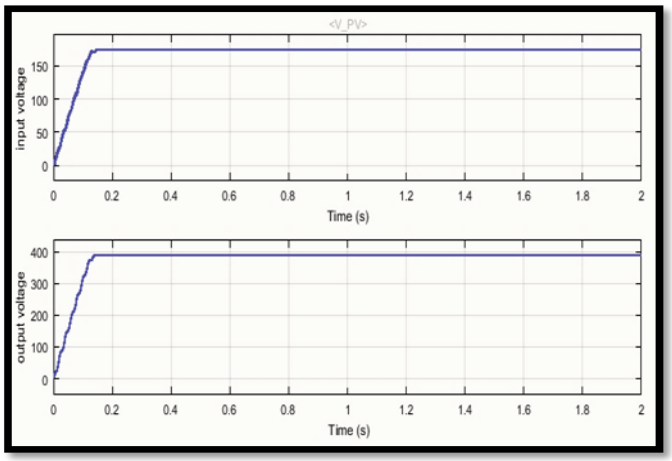
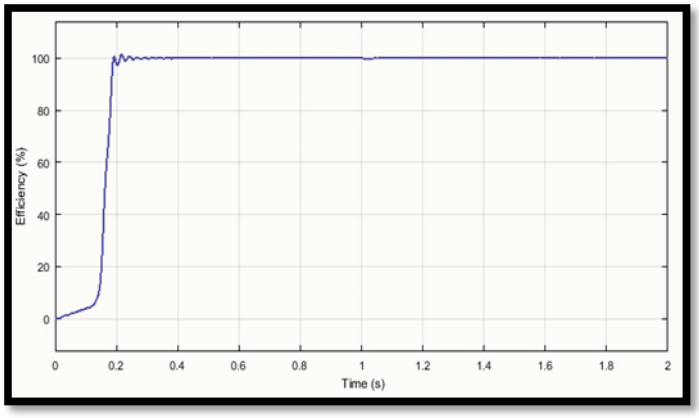


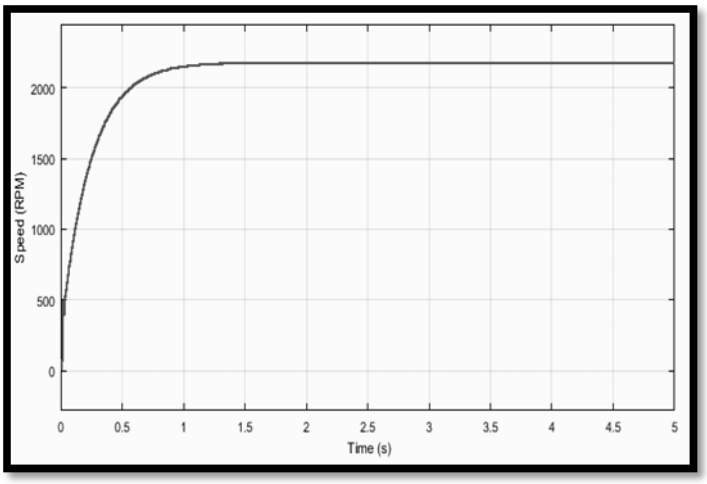
Figure 11 (a) Input and Output Waveform using P&O Method



(b) Input and Output Waveform using Cuckoo Search algorithm



(c) Efficiency of BLDC Motor



(d) BLDC Motor Speed Curve

CONCLUSION

The proposed voltage lift techniques is applied in DC-DC converter with solar PV MPPT algorithm. Here Cuckoo search algorithm is used for MPPT, which has good dynamic response. The proposed work increases the voltage transfer gain in power- law. The converter output is used to drive BLDC motor. Simulation results validates the theoretical results

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