PalArch's Journal of Archaeology of Egypt / Egyptology

FUZZY LOGIC CONTROLLED PV-FED-FLY BACK-CONVERTER-SYSTEM

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A.WiseminLins Fuzzy Logic controlled PV-Fed-Fly Back-Converter-System-- Palarch's Journal Of Archaeology Of Egypt/Egyptology 17 (9). ISSN 1567-214x

ABSTRACT:
Power Quality improvement utilizing PV-based fly back-system is a trustworthy technique. This effort-deals-with-fly-back-converter along-with battery and PV-sources.This work deals withFuzzy logiccontrolled PV-fed-Fly-Back-Converter-Systems(FBCS) . DC supply voltage from PV& Battery are applied to Fly back inverters. The yield of fly back inverters is rectified & they are applied RL-load & DC-motor load respectively. MATLAB - Simulink model for FBCS is established utilizing the fundamentals of Simulink and cascaded-loop examinations are implemented with Recommended FLC. CL- FBCS (closed-loop-system)FuzzyLogic controller are simulated, their outcomes are compared. Comparison of closed loop FBCS is done in terms of rise time, settling time and steady –state- error with a PI controller.

1. Introduction

Due to population growth and the modern industrial society, the energy demand increases which motivate the use alternative energy to improve power quality and the energy efficiency. Among all the renewable source of energy, the use of PV energy has emerged as primary resources because the solar energy is clean, green environmental friendly and in exhaustible. The PV system has the ability which converts solar radiation into DC voltage .Such a PV system can be either grid connected or stand alone. The grid connected PV system become more popular than standalone due to their application in distributed generations. The efficiency and stability of the PV system are improved by the power electronic conversion devices.

The Photovoltaic system consists of a PV module, Fly back converter, MPPT controller and an electrical grid. The maximum power point algorithm (P&O) tracks the maximum power and the output can be matched with the loads. The main aim of this paper is to generate the electricity from

PV and delivering power to industrial loads or domestic loads. In major, the PV panels are designed in to have an output voltage of 23-38V and rated power 160 W.Fuzzy logic controller is used to track the maximum power from MPPT.A Fuzzy logic controller is an intelligent control system that smoothly interpolates between the rules. Fuzziness describes event ambiguity. It measures the degree to which an event occurs, not whether it occurs. Fuzzy theory is a powerful tool in the exploration of complex problems because of its ability to determine outputs for a given set of inputs without using a conventional, mathematical model. Fuzzy theory becomes easily understood because it can be made to resemble a high level language instead of a mathematical language. To describe a universe of discourse, fuzzy sets with names such as "hot" and "cold" are used to create a membership function. By determining the degree of membership of an input in the fuzzy sets of this membership function, the role of membership functions play in decoding the linguistic terminology to the values a computer can use.

Membership functions are designed by experts with knowledge of the system being analyzed. fuzzy logic controller is simply a set of rules describing a set of actions to be taken for a given set of inputs .By using a linguistic approach, fuzzy theory can be integrated into control theory using rules of the form IF{condition} THEN{action}. In this same way the input variables can be partitioned into overlapping sets which have a linguistic correlation to form a membership function. These fuzzy sets are most often triangular in shape but trapezoids and Gaussian functions have also been used. The membership values control the degree to which each rule "fires", illustrating the interdependent relationship between the rule set and the membership functions. This paper deals with the PV array is connected to the utility grid through a Fly back converter to optimize the PV output and AC inverter system. The proposed models are simulated in Matlab/Simulink Software.

System Description

2Solar Photo Voltaic System

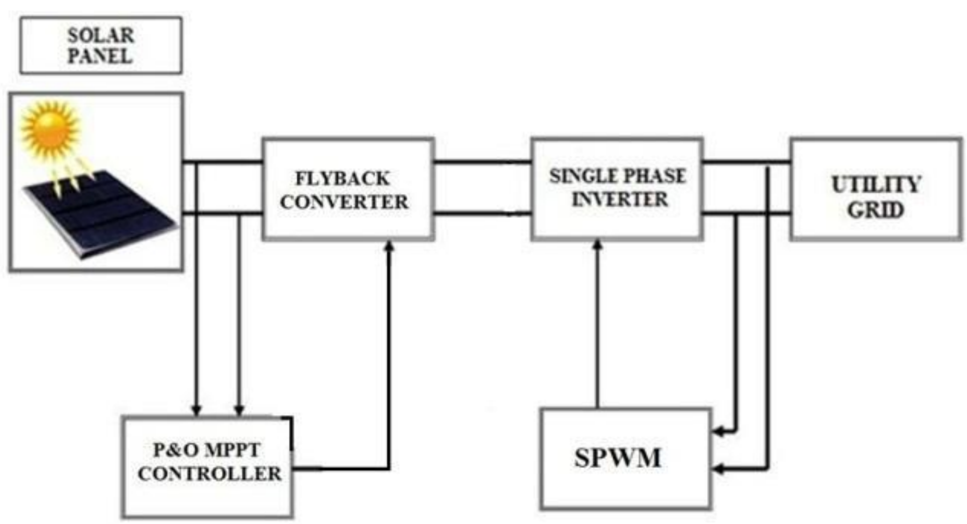


Fig. 1 Proposed System Block Diagram

The above model consists of PV arrays which are converted into DC power, a fly back converter to get DC output along with an AC output and an inverter. The converters convert the DC power to AC power. The generated AC power is injected into the utility grid or to the local loads.

3.Fly -back Converter

The Fig2 shows the usual configuration of the fly- back converter. It is an isolated buck-boost converter with an inductor split which consist of less number of components than the conventional boost converter and it operate with a low inductance value. The MOSFET switch is connected to the primary side of the gate drive circuit and maintains the desired output voltage. The transformer polarity is used for voltage isolation between input and output voltage. The unregulated dc voltage from the PV arrays is given as input to the fly back converter. The transformer secondary side winding voltage is rectified and filtered by using a diode and capacitor

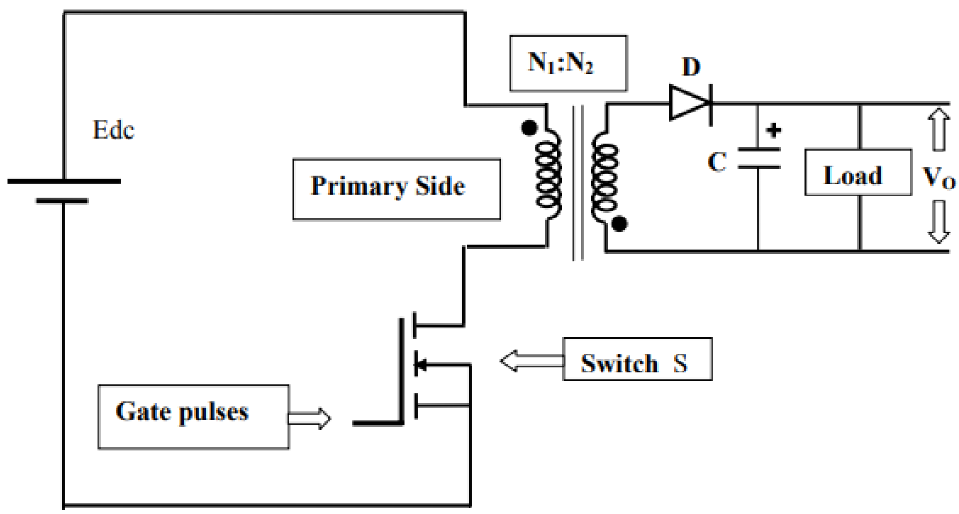


Fig. 2.Circuit diagram of Fly back converter

Output of PV is stepped up using fly-back converter. The ripple in the output is filtered using cascade filter. The pulses required by fly-back converter are generated by a PIC and they are amplified by using a driver**.** The Block diagram of Existing and proposed is appeared in Fig 3. Block diagram of open-loop FBCS is appeared in Fig 5.

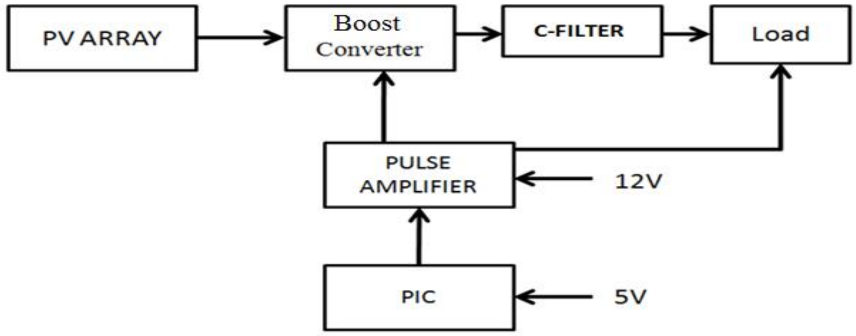


Fig.3. Block diagram of Existing system

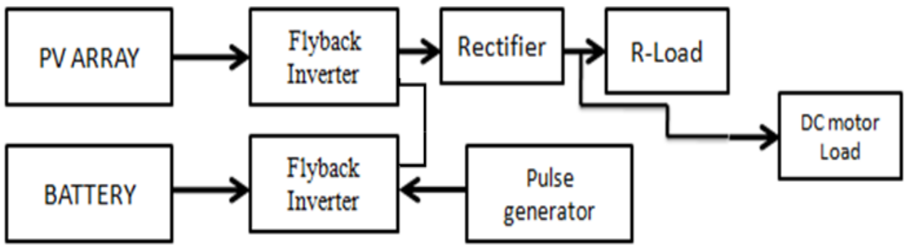


Fig 4. Block Diagram of open-loop FBC- system

Block diagram of closed loop Fuzzy Logic controlled FBCS system is shown in Fig.5. The output-voltage of -FBCS is related with a reference-voltage. The flaw is pragmatic to the Fuzzy Logic-controller. The output of comparator updates the pulse width applied to FBCS.

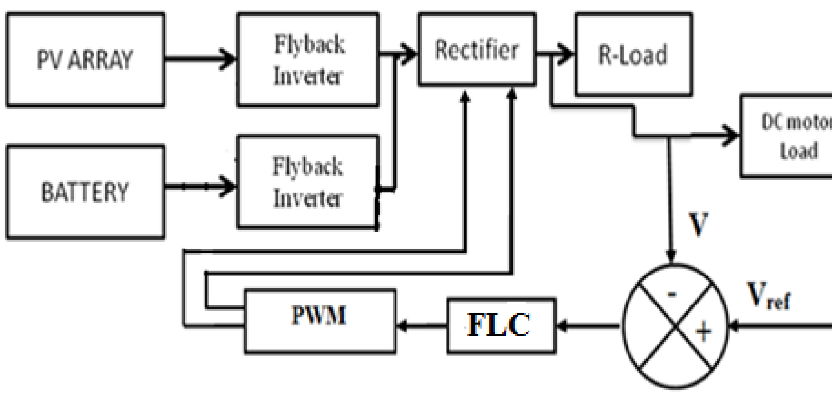


Fig 5Block diagram of closed loop Fuzzy Logic controlled FBC- system

.Fuzzy logic controller does not require complex mathematical model of the FBC- system. We need good understanding of the process to be controlled. The control action of the fuzzy controller depends upon the linguistic-rules.

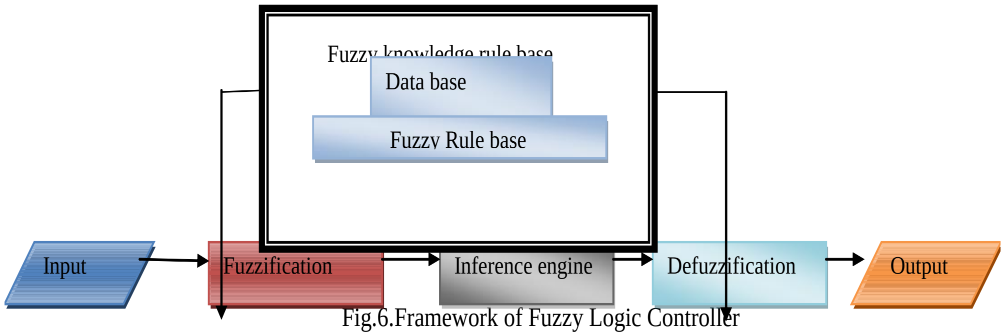


Fig.6.Framework of Fuzzy Logic Controller

(a) Fuzzification-to calculate the fuzzy output(i.e. to evaluate the input variables with respect to corresponding linguistic term in the condition side)
(b) Fuzzy inference-To calculate the Fuzzy output (To Evaluate the Activation strength of every fuzzy rule base and combine their action sides).

(c) Defuzzification-To calculate the actual output (i.e. to convert the fuzzy output in to precise normal value).

FUZZIFICATION

The values of the membership function are assigned to linguistic variables using three fuzzy subsets called Positive Medium, Positivelow, Zero error, Positive High. The linguistic variable voltage error and change in voltage error are the input variables. The output is the firing on FBC which gives desired duty cycle to the switch. Triangular membership functions are used in both input and output variables.

The input linguistic variable voltage error contains 3 membership functions.

ZE: Zero error
PH: Positve High
PM:Positive medium

The input linguistic variable change in voltage error contains 3 membership functions.

ZE: Zero error
PH: Positve High
PM:Positive medium

The output linguistic variable contains 5membership functions
PM: Positive medium
PL: Positive Low
ZE: Zero error
PS: Positive small
PM: Positive medium

The output variables are the commands to vary the duty cycle . The major strength of the fuzzy controllers also lies in the way a non linear output mapping of a number of inputs can be specified easily using fuzzy linguistic variables and the fuzzy rules.

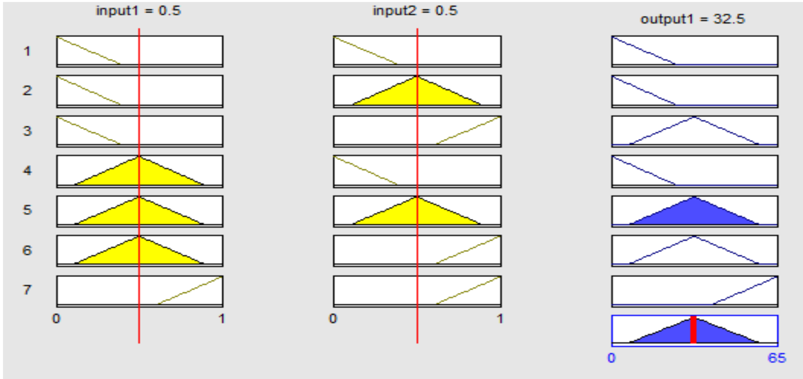


Fig.10. Membership functions of the input and output Rules.

Mamdani fuzzy inference method with triangular membership functions are used to determine the compensated voltage of the setvoltage. The fuzzy inference rules of the FBC system are the collection of linguistic statements in the form of if then statement. There are two inputs and one output of the fuzzy controller. Each has 3 membership functions, there are totally 9 rules. The fuzzy inference rules are designed based on the voltage error and the change in voltage error

DEFUZZIFICATION

The conversion of fuzzy set in to a crisp value is known as defuzzification..Centroid method is used here for the defuzzification process. The actual value of the change in firing angle is calculated by using the following equation

$$x^* = \frac{\sum_{i=1}^{n} x_i . \mu(x_i)}{\sum_{i=1}^{n} \mu\,(x_i)}$$

For a discrete membership function

INFERENCE ENGINE

Inference engine performs three tasks: Application Fuzzy Operator, Application implication method and aggregating all outputs. Inference engine mainly consists of two sub blocks namely, Fuzzy rule base and fuzzy implication. The inputs are now fuzzified are fed to the inference engine and the rule base is then applied. The output fuzzy sets are then identified using fuzzy implication method. Table 1 shows the rule base of fuzzy controller, The commonly used fuzzy implication method is the MIN-MAX method. The consequent fuzzy region is restricted to the minimum of the predicate truth while selecting the output fuzzy set.A collection of rules referring to a particular system is known as fuzzy rule base

Table.1 Fuzzy rule base

e/Δe	PL	PM	PH
PL	PH	PM	PL
PM	PL	ZE	PH
PH	ZE	PM	PH

The PWM gating signals are generated by comparing actual scheme the numerical variables e and ce, are converted into linguistic variables by choosing fuzzy sets

5. Simulation ResultsClosed-loop FBCS with-Fuzzy-Logic-Controller

Simulink-diagram of closed-loop FBCS with-Fuzzy Logic Controller" is delineated in Fig.14.The output-voltage of -converter is related with a reference-voltage. The flaw is pragmatic to the FL-controller. The inputs to FLC are error and derivative-error. The output of FLC is used to adjust pulse-width applied to the converter.

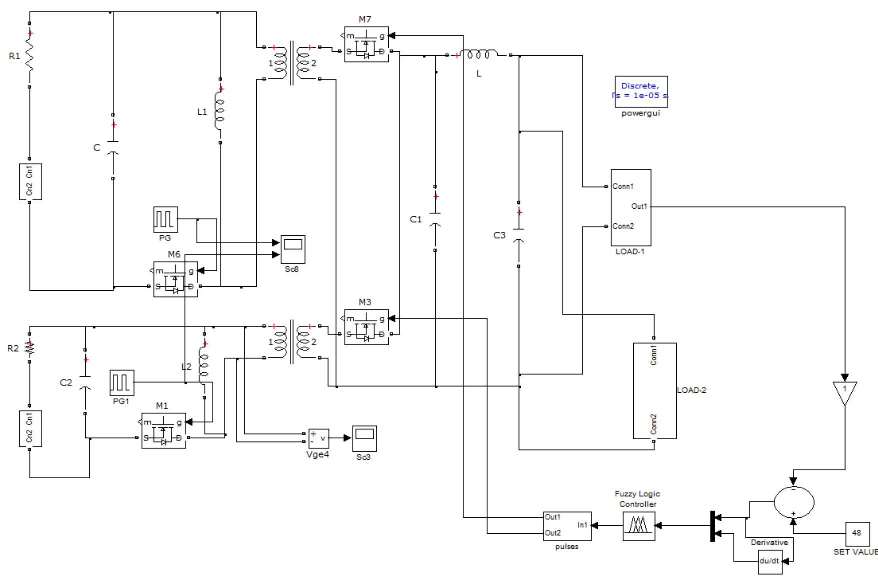
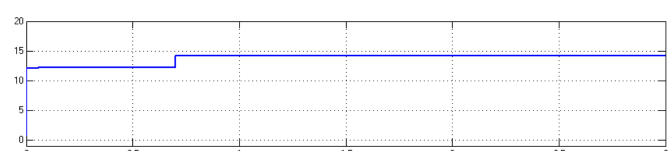


Fig.12.Simulink-diagram of closed-loop FBCS with-Fuzzy Logic-controller

Input voltage applied to FBCS is delineated in Fig.12 and its value is 14.5V.



Time in Sec

Fig.13.Input voltage applied to FBCS

Voltage across R-loadis delineated in Fig.14 and its value is 49V. It quickly settles at 49 V due to FLC.

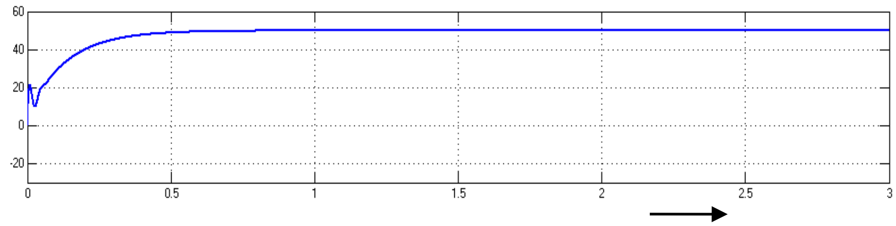


Fig.14.Voltage across R-load with FLC Time in Sec

Current through load is delineated in Fig.15 and its value is 0.22A. . It quickly settles at 0.22 A due to FLC.

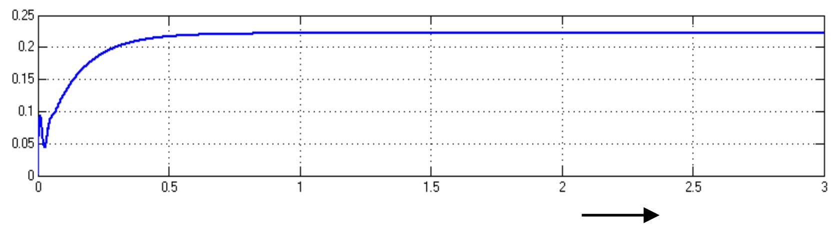


Fig.15.Current through load with FLC

Output power of FBCS with FLC is delineated in Fig.16 anc Time in Sec les at 10 W due to FLC.

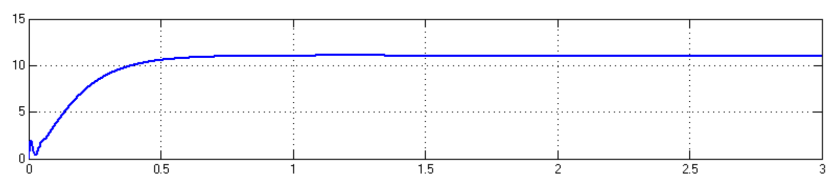


Fig.16.Output power of FBCS with FLC

Motor speed of FBCS with FLC is delineated in Fig.17 and Time in Sec 00 RPM.

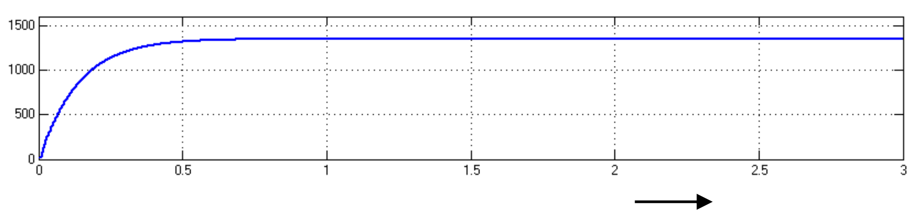


Fig.17.speed response of FBCS with FLC Time in Sec

Motor Torque of FBCS with FLC is delineated in Fig.18 and its value is 2N-m.

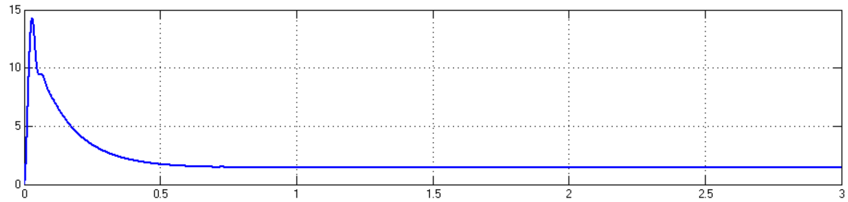


Fig.18.Torque response of FBCS with FLC

Comparison of time-domain-parameters with PI and FLC is given in Table-1. By using Fuzzy Logic-controller, rise-time is reduced from 0.75 Sec to 0.45 Sec; peak-time is reduced from 1.35Sec to 0.76Sec; settling-time is reduced from 2.2 Sec to 0.77Sec; steady-state -error is reduced from 1.5 V to 0.3 V.

Table -2 Comparison of time-domain-parameters of FBCS with PI and FLC

Type of controller	$T_{r(Sec)}$	$T_{p(sec)}$	$T_{s(sec)}$	$E_{ss(volts)}$
PI	**0.75**	**1.35**	**2.2**	**1.5**
FLC	**0.45**	**0.76**	**0.77**	**0.3**

Conclusion

This work deals with PV-fed-fly-back-converter-system. OFBCS(Open-loop-FBCsystem) with disturbance, CLFBCS(closed-loop-system)Fuzzy Logic- controller are simulated their outcomes are evaluated. The settling time with FLC is reduced to 1.3 sec. The SSE is as low as 0.6 V. Hence, the response with FLC is better than that of PI-controlled-system. The hardware for FBCS is contrived and verified. The investigational outcomes match with the hardware results. The contributions of the present work are reduction in settling-time and voltage-steady-state-error to a minimum using FLC. The benefits of the recommended system are decreased torque-ripple and enhanced response. The disadvantage of this structure is the asymmetry in the FB-waveform.

The scope of the current work is the comparison of PI and FL-controlled closed-loop FBCsystems. The comparison of fuzzy control and model predictive control Fly back converter system could be done in future. The hardware may be implemented using FPGA to enhance the switching-frequency level of FBCS-converter.

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