ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 3, Issue 7, January 2014

A Review : Single Input Fuzzy Logic Controller

Vishal Revatkar, M. N. Thakare, G. D. Korde
Dept. Of EXTC Engg., B. D. C. O. E., Sevagram, Wardha(MS)

Abstract - This paper présents the use of boost converter with Single Input Fuzzy Logic converter. This shows how Single Input Fuzzy Logic Controller is better than Proportional Derivative Controller and Conventional Fuzzy Logic controller in distrubances in load or reference voltage changes. It also reduces the inputs of system. Boost converter has nonlinear and time-invarient nature, because of that design of high performance controller for the boost converter presents a challenging task. So for that classical controller (Proportional Integral Derivative, Sliding mode controller) was used by designer but they are unable to respond satisfactory to a large operating point verification. The work is done using Fuzzy Logic toolbox in MATLAB simulink software.

Keywords **-Boost Converter, Fuzzy Logic Converter, Signed Distance Method, MATLAB.**

I. INTRODUCTION

Boost converter is widely used in power electronics system where DC to DC converter needed mostly. A good controller is one which is able to regulate output voltage when input voltage and reference is changed and also able to stabilize the system for any input distrubances and load changes. A boost converter is type of power converter with an output DC voltage greater than the input DC voltage. This type of circuit is use to step-up a source voltage to a higher regulated voltage, allowing one power supply to provide different deriving voltages. In this method we are going to derive a new variable in FLC which help to reduce the total number of rule compared to existing FLC's and hence generation and tuning of control rules is easier. To alleviate the dependency on the mathematical model, non-model based controller have been proposed. Among the most is the Fuzzy Logic controller(FLC). FLC is a linguistic-based controller that tries to solve problems by means of systematic rule inferences. It does not require precise mathematical model, very robust and has excellent immunity to external distrubances. The plants having difficulties in deriving mathematical model also having performance problems or limitations with Conventional linear schemes, the Fuzzy Logic Controller is one of useful control schemes. Fuzzy Logic deals with reasoning that is approximate rather than fixed and exact. Traditional binary sets which take on true or false values but Fuzzy Logic has been extended to handle true value ranges between 0 and 1. If the temperature can be divided into a ranges of different 'states', such as 'cold', 'cool', 'moderate', 'warm', 'hot', 'very hot' etc. Defining these states is a uncertain. Because an arbitrary threshold might be set to divide 'warm ' from 'hot' but this would result in discontinuons change. To make this correct or to make the state Fuzzy allow them to change gradually from one state to the next by using Membership functions.

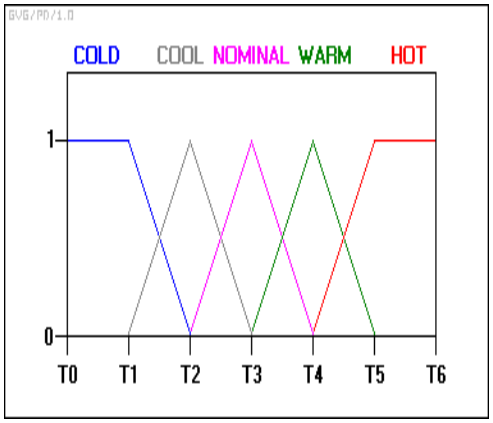

Fig 1 Member ship Function

The objective of fuzzy logic is to develop computational methods that can perform reasoning and problem solving tasks that require human intelligence. Fuzzy logic has an additional objective to explore an effective tradeoff b/w precision and the cost in developing an approximate model of a complex system.

II. LITERATURE REVIEW

Byung Jae Choi has proposed a simple FLC called the SFLC. In this paper we observed that the rule table for conventional PD or PI-type FLC has skew symmetric property and absolute magnitude of control input is proportional to the distance from its main diagonal line. These properties were also satisfied in the general case of input FLC's using the error and its time derivative terms as fuzzy input variables. These facts allowed us to derive a new variable called the signed distance. The signed distance was used as a sole input variable of the proposed SFLC. The number of rules was greatly reduced compared to conventional FLC's. Generation, modification and tuning of control rules were much easier. Furthermore, the control performance was nearly the same as that of the conventional skew symmetric FLC's, which has been confirmed through computer simulations using arbitrary two nonlinear plants. It is possible to design the FLC very simply while obtaining the desired control performance by proposed SFLC [1]. N. F. Nik Ismail has describes the design of a fuzzy logic controller using voltage output, improving the dynamic performance of boost dc-dc converter by using MATLAB simulink software. The design and calculation of the components especially for the inductor has been done to ensure the converter operates in continuous conduction mode. The evaluation of the output has been carried out and compared by software simulation using MATLAB software between the open loop and closed loop circuit. The simulation results are shown that voltage output is able to be control in steady state condition for boost dc-dc converter by using this methodology. A simple algorithm based on the

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 3, Issue 7, January 2014

prediction of fuzzy logic controller, possibly using the fuzzy rules parameter, is showing to be more convenient than the circuit without fuzzy. As the 20 V input on the output voltage for the closed loop circuit (with fuzzy logic controller) with 0% overshoot shows the better performance compared to the open loop circuit (without fuzzy logic controller) whereby it has 80% overshoot. Moreover, the value of the output current also improving corresponds to the system and produce a constant value for the output current as 0.5 A. Using a closed loop circuit with fuzzy logic controller, it is confirmed that the boost dc-dc converter gives a value of output voltage exactly as circuit requirement [2]. Essam Natsheh has proposed fuzzy logic and proportional integral derivative controllers are compared for use in direct current motors positioning system. A simulation study of the PID position controller for the armature-controlled with fixed armature current DC motors is performed. Fuzzy rules and the interfacing mechanism of the fuzzy logic controller (FLC) are evaluated by using conventional rule lookup tables that encode the control knowledge in a rules form. The results obtained from the FLC are not only superior in the rise time, speed fluctuations, and percent overshoot but also much better in the controller output signal structure. Results of PID like FLC indicate that even without knowing the details of the control plants, we were able to construct a well performed fuzzy logic controller based on the experience about the position controller [3]. For applications to power converters .V. S. C. Raviraj presents a comparative evaluation of the proportional integral, sliding mode and fuzzy logic controllers. The differences between the characteristics which lead to varying performance are outlined. Both the fuzzy logic controller and sliding mode controller also demonstrates certain similarities in this paper. Sensitivity of these controllers to supply voltage disturbances and load disturbances is studied and results are presented. The study of fuzzy logic control, PI control suggests that FLC performs satisfactorily in regulating the output during external disturbances. FLC shows negligible transient overshoot compared to PI response. PI shows under damped response during disturbances due to off tuned gain constants. From the above study, FLC seems to be good controller for application in power electronic systems [4]. Kanakasabai Viswanathan has proposed Nonlinear Function Controller. In his paper, it is shown that the fuzzy logic controllers (FLCs) for control of power electronic converters also the rule table of most of the two-input FLCs used with power converters can be approximated into a single nonlinearity. This allows the controller to be easily realized using simple, fast, and inexpensive analog circuits and simplified "nonlinear function controller (NLFC)". The PI-FLC results being replaced by a simple "nonlinear PI controller (NPIC)". Using this simplification, a good design with dynamic performance in power converters is explained. Experimental results also help to show the superior dynamic performance of the converter with NPIC versus that of a linear-PI controller [5]. Fazel Taeed has described the FPGA implementation of the SIFLC to control a boost converter without the use of an external ADC. It was shown that the SIFLC with PWL control surface has identical performance to the CFLC. Due to the simplicity of the SIFLC algorithm, its implementation requires only 460 logic gates and four I–O pins of the FPGA. The analog to digital conversion is achieved by a combination of standard op-amp circuits and pulse width control using the FPGA. The SIFLC has superior performance for load and reference changes with very small overshoot and fast settling time as compared to PI [6].

III. PROBLEM DEFINATION

In conventional FLC accuracy is the main disadvantage. The numbers of inputs is more in CFLC. Execution time for PID controller is more as compared to SIFLC. Numbers of inputs in PID controller are more as in SIFLC. Voltage regulation is poor in PID controller. To reduce the problems in CFLC & PID controller we can design single input FLC. This will help to reduce the number of input, which is the good method for non-linear mathematical model.

IV. PROPOSED WORK

The proposed work describes the application of the Single Input Fuzzy Logic Controllers (SIFLC) to regulate the output voltage of a Boost (step-up) DC to DC power converter. The SIFLC is derived from the Signed Distance Method which reduces the multi-input Fuzzy Logic Controller (FLC) with Toeplitz rule table structure.

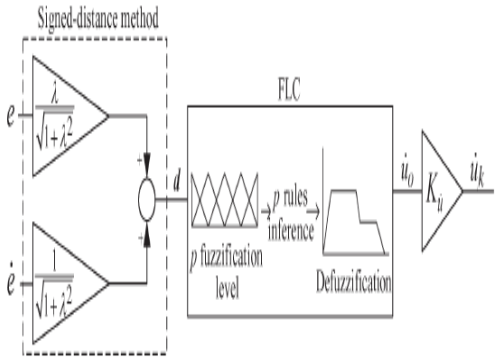

Fig.2 Generalized dia. Of single i/p fuzzy logic controller

However a Toeplitz is defined in the form of matrix. A Toeplitz matrix can also be decomposed in time. Toeplitz matrix is also closely connected with Fourier series. Effectively, it allows for the rule table to be approximated to a one dimensional piecewise liner control surface. Also design a PID controller and conventional controller for comparative study.

V. CONCLUSION

In this paper the idea of single input fuzzy logic controller is tried to explain. The design of a single input fuzzy logic controller for boost converter is described in this paper. Experimental results will show the better performance of SIFLC for disturbances in load or reference voltage changes. Also tried to show in which parameter it will better than PID controller and conventional FLC controller.

ISSN: 2277-3754
ISO 9001:2008 Certified
International Journal of Engineering and Innovative Technology (IJEIT)
Volume 3, Issue 7, January 2014

REFERENCES

[1] Byung Jae Choi, Seong Woo Kwak, Byung Kook Kim, "Design and stability analysis of single-input fuzzy logic controller," IEEE Transactions on Systems, Man, and Cybernetics, Part B: Cybernetics, vol.30, no.2, pp.303-309, Apr. 2000.

[2] N. F. Nik Ismail, I. Musirin, R. Baharom, D. Johari, "Fuzzy Logic Controller on DC/DC Boost Converter", 2010 IEEE International Conference on Power and Energy, Nov 29 - Dec 1, 2010, Kuala Lumpur, Malaysia.

[3] Essam Natsheh, Khalid A. Buragga,"Comparison between Conventional and Fuzzy Logic PID Controllers for Controlling DC Motors", IJCSI International Journal of Computer Science Issues, Vol. 7, Issue 5, September 2010.

[4] Raviraj and P.C. Sen, "Comparative Study of Proportional Integral, Sliding Mode, and Fuzzy Logic Controller for Power Converters", IEEE Transactions on Industry Applications, VOL. 33, NO. 2, March/April 1997.

[5] Kanakasabai Viswanathan, Ramesh Oruganti, and Dipti Srinivasan, "Nonlinear Function Controller: A Simple Alternative to Fuzzy Logic Controller for a Power Electronic Converter", IEEE Transactions on Industrial Electronics, VOL. 52, NO. 5, October 2005.

[6] Fazel Taeed, Zainal Salam, and Shahrin M. Ayob, "FPGA Implementation of a Single Input Fuzzy Logic Controller for Boost Converter with the Absence of an External Analog to Digital Converter", 1208 IEEE Transactions on Industrial Electronics, VOL. 59, NO. 2, February 2012.

[7] S. Chiu, "Using fuzzy logic in control applications: beyond fuzzy PID control", vol.18, no.5, pp.100-104, Oct 1998.

[8] K. S. Tang, Man Kim Fung, Chen Guanrong, and S. Kwong, "An optimal Fuzzy PID Controller", vol. 48, no.4, pp.757-765, Aug 2001.

[9] So Wing Chi, C. K. Tse, and Lee Yim Shu, "Development of a Fuzzy Logic Controller for DC-DC converters: Design, computer simulation and experimental evaluation", vol.11, no.1, pp.24-32, Jan 1996.

[10] S. M. Ayob, Z. Salam and N. A. Azli, "Piecewise Linear Control Surface for Single I/P Nonlinear PI-Fuzzy Controller", The 7th International Conference on Power Electronics and Drive Systems (PEDS 2007), 7 – 30 November 2007, Bangkok, pp. 21533 – 1536.

[11] B. Bryant, and M. K. Kazimierczuk, "Modeling the closed-current loop of PWM boost DC-DC converters operating in CCM with peak current mode control", vol.52, no.11, pp. 2404- 2412, Nov. 2005.

[12] K. Viswanathadn Srinivasarn, O. Rucanti," A Universal Fuzzy Controller for A Non- linear Power Electronic Converter", Department of Electrical and Computer Engineering, National University of Singapore, IO, Kent Ridge Crescent, Singapore-11926.