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Design Buck Converter Using Fuzzy Logic Controller

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ABSTRACT

This paper presents an approach for DC-DC converter generally consists of power semiconductor devices which are operate as an electronic switches. Operation of these switching devices causes inherently nonlinear characteristic to the DC-DC Converters include buck converter. Proposed system consists of development of fuzzy logic controller for generating control PWM pulses of required duty cycle for switch of the buck converter to maintain the constant output voltage. Duty cycle of the converter is adjusted continuously to obtain required output voltage. However, implementations of this control method to nonlinear system like buck converters will suffer from dynamic response for the converter output. To achieve a stable and fast response, closed loo controller were applied to control buck converters. In this Paper, performance analysis of FLC based buck converter has been done by using of MATLAB-Simulink.

KEYWORDS: *DC-DC Converter, Buck Converter, Fuzzy Logic Controller, MATLAB-Simulink.*

I. INTRODUCTION

DC-DC converters are the mostly used circuits in power electronics appliances. They can be found in almost every electronic appliance nowadays, since all semiconductor components are powered by DC sources. DC-DC converters are basically used for stabilizing a given dc voltage to a desired value. This is generally achieve by using chopping and filtering of input voltage through suitable switching action, generally implemented by using pulse width modulation. The buck is a popular nonisolated, inverting power stage topology, sometimes called a step-up/down converter. Power supply designers choose the buck converter because the output voltage is inverted from the input voltage, and the output voltage can be either higher or lower than the input voltage. The topology gets its name from producing an output voltage that can be higher or lower in magnitude than the input voltage [4]. Buck converter is an intriguing subject from the control point of view, due to its intrinsic non-linearity. DCDC converter consists of power semiconductor devices which operate as electronic switch. Operation of various switching device causes the inherently nonlinear characteristic to DC-DC converters such as buck converter. Consequently, converter requires controller with high degree of dynamic response. PID controllers are generally used with converters because of its simplicity. However, implementation of this control method to nonlinear system like power converters will suffer from dynamic response of the converter output. One of the design targets for electronic engineers is to improve the efficiency of power conversion. For PWM (pulse-width modulation) converters, switching loss is an important performance measure. Fuzzy logic control has been applied successfully to a wide variety of engineering problems, including dc to dc converters. Fuzzy control is an attractive control method because its structure, consisting of fuzzy sets that allow partial membership and "if-then" rules, resembles the way human intuitively approaches a control problem. This makes it easy for a designer to incorporate heuristic knowledge of a system into the controller. Fuzzy control is obviously a great value for problems where the system is difficult to model due to complexity, non-linearity and imprecision. DC-DC converters fall into this category because they have a time varying structure and contain elements that are non-linear and have parasitic components [5]. Buck converter is used where constant output voltage required for a specific application. Buckconverter operate in buck as well as boost mode this is most effective advantage of the buck converter. In this paper, MATLAB simulink is used as a platform in designing the buck converter using fuzzy logic controller in order to study the dynamic behavior of DC-DC converter and performance of proposed system.

II. PROPOSED METHOD

Buck converter using fuzzy logic controller is as shown in Fig-1 [3]. It shows the basic connections of the peripherals, along with description of the components such as DC-DC converter, Load, Fuzzy logic controller, PWM generator, Analog to digital converter.

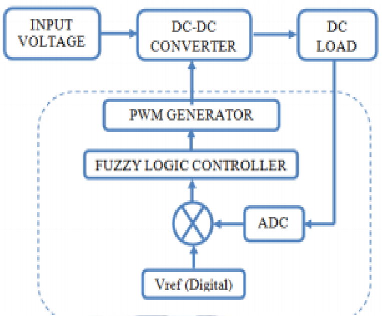

Fig 1 buck converter with fuzzy control block diagram

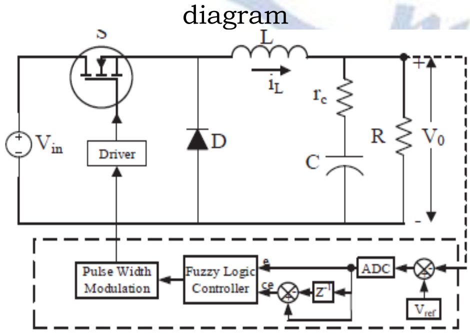

Fig. 2. FLC based closed loop control of buck converter.

A DC-to-DC converter is a gadget that acknowledges a DC info voltage and produces a DC yield voltage. Normally the yield delivered is at an alternate voltage level than the info. Also, DC-to-DC converters are utilized to give clamor confinement, force transport regulation, and so on. This is a synopsis of a portion of the prevalent DC-to-DC converter topologies.

2.1 BUCK CONVERTER

In this circuit the transistor turning ON will put voltage Vin toward one side of the inductor. This voltage will tend to bring about the inductor current to rise. At the point when the transistor is OFF, the present will keep coursing through the inductor however now moving through the diode.

We at first accept that the current through the inductor does not achieve zero, in this way the voltage at Vx will now be just the voltage over the leading diode amid the full OFF time. The normal voltage at Vx will rely on upon the normal ON time of the transistor gave the inductor current is persistent.

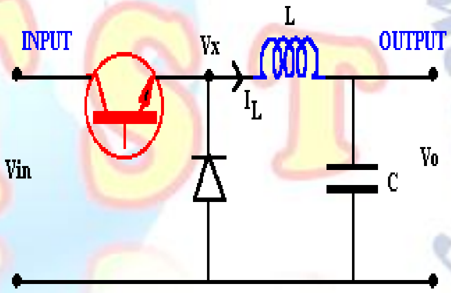

Fig 3 Buck Converter

III. FUZZY LOGIC

In recent years, the number and variety of applications of fuzzy logic have increased significantly. The applications range from consumer products such as cameras, camcorders, washing machines, and microwave ovens to industrial process control, medical instrumentation, decision-support systems, and portfolio selection. To understand why use of fuzzy logic has grown, you must first understand what is meant by fuzzy logic.

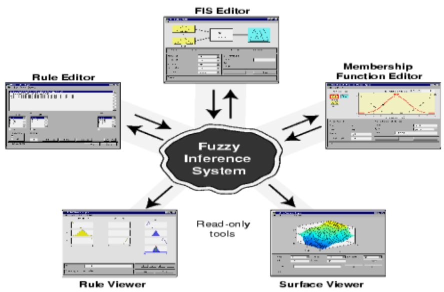

Fig.4The Primary GUI Tools of the Fuzzy Logic Toolbox

The FIS Editor handles the high level issues for the system How much input and output variables? What are their names? The Fuzzy Logic Toolbox doesn't limit the number of inputs. However, the number of inputs may be limited by the available memory of our machine. If the number of inputs is too large, or the number of membership functions is too big, then it may also be difficult to analyze the FIS using the other GUI tools.

The Membership Function Editor is used to define the shapes of all the membership functions associated with each variable. The Rule Editor is for editing the list of rules that defines the behavior of the system.

3.1The FIS Editor

The following discussion walks we through building a new fuzzy inference system from scratch. If we want to save time and follow along quickly, we can load the already built system by typing fuzzy tipper This will load the FIS associated with the file tipper.fis (the .fis is implied) and launch the FIS Editor. However, if we load the pre built system, we will not be building rules and constructing membership functions.

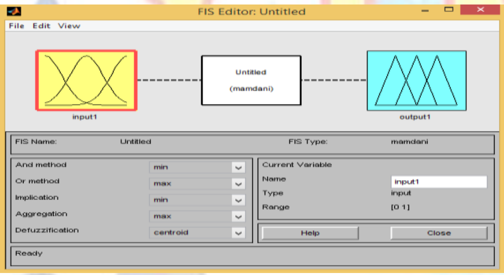

Fig.5The FIS Editor

We will see the diagram updated to reflect the new names of the input and output variables. There is now a new variable in the workspace called tipper that contains all the information about this system.

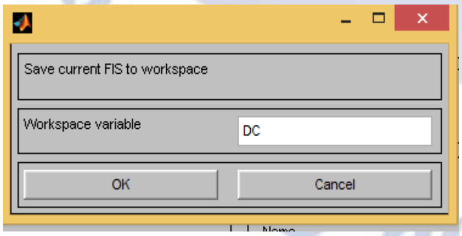

Fig.6'Save to workspace as…' window

By saving to the workspace with a new name, we also rename the entire system. Our window will look like as shown in Fig.7.

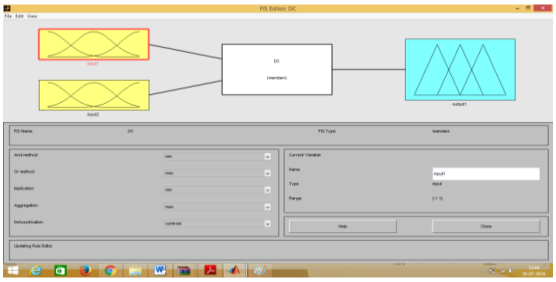

Fig.7The Updated FIS Editor

3.2 The Membership Function Editor

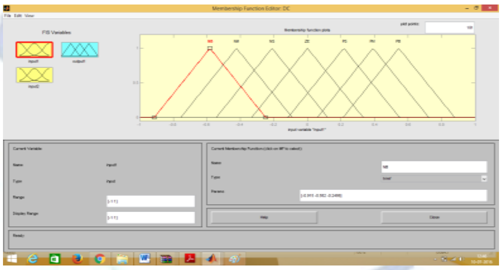

Fig.8The Membership Function Editor

Fig.9 Add MFs… Window

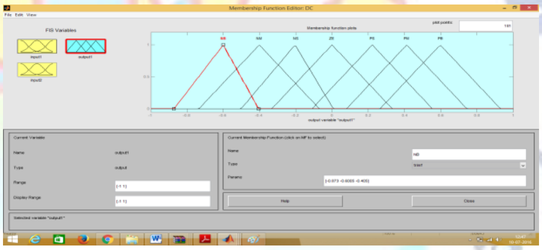

Fig.10 The Updated Membership Function Editor

3.3 The Rule Editor

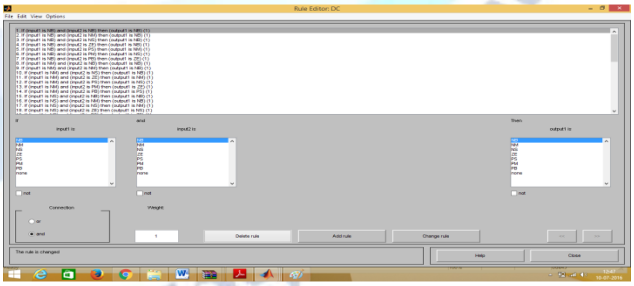

Fig.11 The Rule Editor

	NB	NM	NS	ZE	PS	PM	PB
NB	NB	NB	NB	NB	NM	NS	ZE
NM	NB	NB	NB	NM	NS	ZE	PS
NS	NB	NB	NM	NS	ZE	PS	PM
ZE	NB	NM	NS	ZE	PS	PM	PB
PS	NM	NS	ZE	PS	PM	PB	PB
PM	NS	ZE	PS	PM	PB	PB	PB
PB	ZE	PS	PM	PB	PB	PB	PB

Fig.12 Fuzzy rules

IV. SIMULATED RESULTS

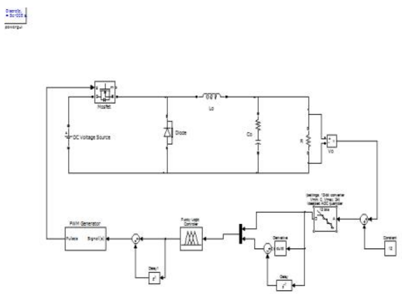

Fig 13 Simulink model

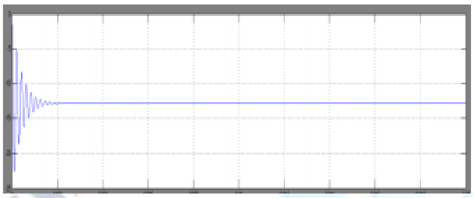

Fig 14 output voltage

V. CONCLUSION

In this paper, Analysis of Buck Converter with fuzzy logic converter is presented. The output voltage of Buck Converter can be stabilized using variable duty cycle generated by the fuzzy logic controller. Buck converter with closed loop fuzzy logic controller precisely improved the dynamic response of the system during load as well as source variation with reduced voltage and current ripple. Moreover, the circuit is simpler and much cheaper compared to other control mechanisms where large numbers of components are needed. Finally performance analysis of Buck Converter with fuzzy logic controller has been done by using of MATLABSimulink.

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