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High Performance of Fuzzy Direct Power Control Using Non Conventional Energy Sources.

KEYWORDS: FLC-DPC, PWM converters, Non conventional energy source.

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ABSTRACT *This paper presents an approach of direct powercontrol (FLC-DPC) strategy for to three phase PWM converters. In this novel strategy the fuzzy logic control (FLC) with Wind input has been used. The wind is free and with modern technology it can be captured efficiently with low cost of production.Energy is generated without polluting environment [2]...The basic idea of fuzzy rulessynthesis is based on the knowledge of the instantaneousvariation of active and reactive power flows to the grid. Themain advantages of this approach is using a renewable resource as an input and control of active and reactive power flows and maintaining thedc-bus voltage of the converter close to the reference value. Results have proven excellent performance, andverify the validity of the proposed DPC strategy which is muchbetter than the classical direct power control strategies.*

1. INTRODUCTION:

Three phase voltage-source inverters are employed in many grid-connected applications such as uninterruptible power systems, and distributed generating systems. Based on the principles of direct torque control (DTC) strategy for ac machines, another control strategy called direct power control (DPC) is based on the instantaneous active and reactive power control was developed for the control of grid-connected voltage sourced converters (VSC). A DPC strategy of three phase PWM converter based on fuzzy logic rules for switching state selection of the converter is presented with wind energy as source. The main contribution of this paper is to regulate the instantaneous active and reactive powers of grid-connected PWM converters power control in DPC strategy and FLC approach [1] with Wind as input supply, so as to maintain the DC bus voltage at the required level.

The designed strategy is shown, analyzed in Section-2,Sections-3 present the simulation results of a PWM converter system to demonstrate the performance of the proposed strategy. Finally, the conclusion is drawn in Section4.

2. DESIGN STRATEGY:

Below shown figure 1. Gives the "Block diagram of diagram of Direct Power Control with wind supply using FLC", Here using Fuzzy logic controls rules we have controlled the speed of an Induction motor.

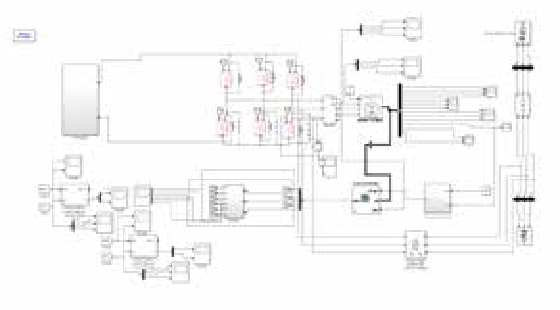

Figure 1.Block diagram of Direct Power Control with wind supply using FLC

2.1 PROPOSED POWER CONTROL USING FLC APPROACH:

The FLC and SMC strategy with variable control structure is based on the design of discontinuous control signal that drives the system operation states toward special manifolds in the state space. In this paper, we propose then to develop an approach to power control based on fuzzy logic control. In this scheme, instantaneous active and reactive power errors $p\ \varepsilon$, $q\ \varepsilon$ and voltage position are used as fuzzy logic variables. At each sampling time, value of power errors and voltage position are converted to their corresponding fuzzy variables converters by means of fuzzy logic rules, to restrict instantaneous active and reactive power errors simultaneously at the next sampling instant.

A. Fuzzyification: The fuzzy logic control requires that each control variables which define the control surface be described in fuzzy set symbols using linguistic rules. Two fuzzy subsets have been used in this paper, these are: P (positive error), N (negative error). For each of these fuzzy sets, a triangular membership functions are taken for the first and second input variables (errors of active and reactive power) and trapezoidal membership functions are taken for the third input variable is the vector position of voltage grid. Singletons membership functions are taken for the output variable (the switching state of the converter). These membership functions are shown in Fig.2. These membership functions are used to decompose each system variables into fuzzy domain. The membership functions symbolize the extent that which variable is a member of a particular rule. This procedure of converting input/output variables to linguistic rules is designated as Fuzzification that is performed using the rule bases shown in below.

B. Inference Mechanism:

The behavior of the control surface which explains the input and output variables of the system, is managed by a set of rules. A characteristic of rules would be: If (fuzzy suggestion) Then (fuzzy suggestion). These rules are used to decide the proper control action. Each control rule can be formulated as follows:

i Rule : If $p\ \varepsilon$ is i A , $q\ \varepsilon$ is i B and θ is i C then n is i D

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(*Ai* ,*Bi* ,*Ci* ,*Di*) present the membership functions.

These rules used to create a fuzzy set that semantically represents the concept associated with the rule. To have a smooth, stable control surface. The rule bases that can be used in this paper are shown in table1. This table shows the adequate voltage vector applied to the converter for a position of grid voltage vector.

C. Defuzzification: The fuzzy set that depicting the controller output in linguistic rules has to be transformed into a feasible solution variable before it can be used to control the system. This is obtained by using a Defuzzification. Various methods of Defuzzification are available. The most prevalently used methods are Mean of Maxima and Center of Area. Most control applications use the center of area method. This method calculates the center of gravity of the final fuzzy space and products a result which is sensitive to all the rules performed. Hence the results tend to move smoothly across the control surface.

The expression of the relative weight to the rule is:

$\alpha = \min(\mu_{Ai}(\varepsilon_p), \mu_{Bi}(\varepsilon_q), \mu_{Ci}(\Delta\theta))$

Using the fuzzy logic and based on the method of Mamdani, the rule has degree to control

The membership degree of the output is given by:
Since the membership function of the output variable is in the form of singleton. In this study the centroid defuzzification is used. The output value to be selected is that which represents the maximum distribution given by the equation.

$$\mu_D(n) = \max_{F_4=1}^{F_4=8}(\mu_D(n))$$

Then the output will be chosen $(n = F_4)$

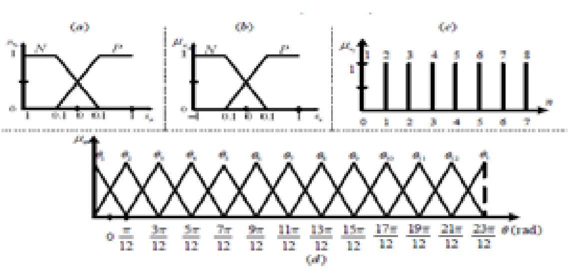

Figure 2: Membership function for (a) Active Power (b) Reactive Power
(c) Output variable (d) Phase of voltage vector grid

P	P	6	1	1	2	2	3	3	4	4	5	5	6
	N	7	7	8	8	7	7	8	8	7	7	8	8
N	P	1	2	2	3	3	4	4	5	5	6	6	1
	N	2	3	3	4	4	5	5	6	6	1	1	2

Table1: INFERENCE TABLE TABLE OF THE FLC-DPC

3. SIMULATION RESULTS:
In order to verify the performance of the proposed strategy based on the FLC approach, simulation studies are involved, were carried out by using MATLAB/Simulink.

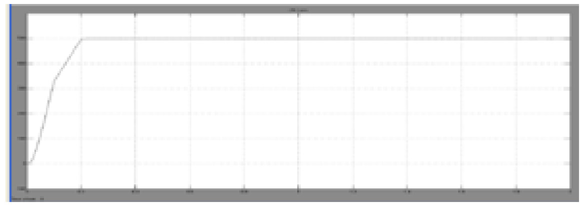

Figure3: Speed control using FLC with 3 phase supply as input.

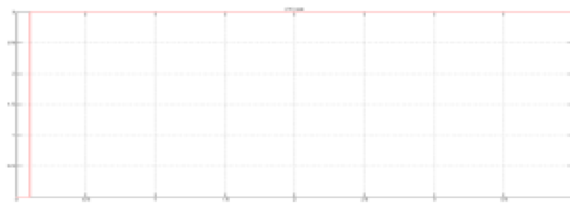

Figure4: Speed control using FLC with renewaable energy source as input.

In the above two figures 3 and 4 we observe that in the figure 4(with wind as input) the motor has taken less time than figure 3 (without wind supply) to settle.

4. CONCLUSION:
This paper proposes an improved direct power control for grid connected PWM converters based on FLC approach with wind as input. System responses with the proposed approach are valided via simulations. It provides more precise speed control minimum noises.

Results have proven excellent performance and very economical [2] with this Wind energy as input.

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