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A Holistic Approach Using Fuzzy Logic Statistical Method For VAR Compensation Using Effective Power Control

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Abstract: *In this paper, a shunt Active Power Filter (APF) is proposed for the pay of symphonious flows and receptive power in contaminated condition and under unequal mains voltage. For this reason, a fluffy rationale controller is created to modify the vitality stockpiling of the dc voltage. The reference current calculation of the shunt APF depends on the immediate receptive power (p-q) hypothesis. We connected the framework dependent on PLL (Phase Locked Loop) so as to control the shunt APF under uneven mains voltage. Hysteresis Controllers is utilized to create exchanging signs of the voltage source inverter. MATLAB/SIMULINK control framework tool kit is utilized to reproduce the proposed framework. The outcomes demonstrate the viability of fluffy rationale control to improve the vitality stockpiling of the DC capacitor, the sinusoidal type of the current and the ideal of the responsive power pay. The proposed framework has accomplished a low Total Harmonic Distortion (THD) which shows the viability of the exhibited strategy.*
Keywords: *FACTS, SMIB SYSTEM CASE STUDY, FUZZY LOGIC*

I. Introduction

Power framework Stability is the capacity of the framework to recapture its unique working conditions after an unsettling influence to the framework. Power framework transient steadiness examination is considered with expansive unsettling influences like unexpected change in burden, age or transmission framework arrangement because of blame or exchanging. Dynamic voltage support and receptive power remuneration have been recognized as an exceptionally huge measure to improve the transient strength of the framework. Adaptable AC Transmission Systems (FACTS) gadgets with a reasonable control methodology can possibly build the framework dependability edge . SVC is one of the critical adaptable AC transmission frameworks (FACTS) gadgets whose adequacy for voltage control is notable. Contrasted and regular exchanged reactors or shunt capacitors, SVC can give control activities ceaselessly and quickly. Likewise, it has been effectively used to clammy out power framework motions [3]. As of late, much exertion has been coordinated towards the utilizations of fluffy control in power frameworks [1-5], additionally there are a couple of papers with a use of fluffy control to SVC [6-8].

A critical commitment to framework damping can be accomplished when a SVC is constrained by some helper signals superimposed over its voltage control circle [9]. It is conceivable to plan a FLC by considering the non linearity of Power framework. In this paper a fluffy based SVC stabilizer utilized for producing the advantageous Signal to voltage control circle of SVC is proposed. The beneficial flag is determined utilizing Fuzzy participation. Fluffy rationale control approach is a rising instrument for taking care of complex issues whose framework conduct is unpredictable in nature. An alluring element of fluffy rationale control is its heartiness in framework parameters and working conditions changes [9]. Fluffy rationale controllers are fit for enduring vulnerability and imprecision to a more noteworthy degree [9]. This paper introduces a technique dependent on fluffy rationale control for SVC controller which soggy out the motions at a quicker rate. Recreation results for a Single Machine Infinite Bus System (SMIB) and a Multi machine framework (WSCC framework) are introduced and talked about.

II. Svc Modeling

Explaining **T**he Static Var Compensator is basically a shunt connected variable Var generator whose output is adjusted to exchange capacitive or inductive current to the system. One of the most widely used configurations of the SVC is the FC- TCR type in which a Fixed Capacitor (FC) is connected in parallel with Thyristor Controlled Reactor (TCR). The magnitude of the SVC is inductive admittance B (α) is a function of the firing angle α and is given by;

$B_{L=}\ \sigma - \sin\sigma / \pi x_l$

$B=B_L-B_C$

An SVC with firing control system can be represented, for the sake of simplicity by a first order model characterized by a gain KSVC and time constants T1 and T_2 as shown in Figure 1 The controller send firing control signals to the thyristor switching unit to modify the equivalent capacitance of the SVC. The fuzzy controller provides an auxiliary control, which is in addition to the voltage feedback loop.

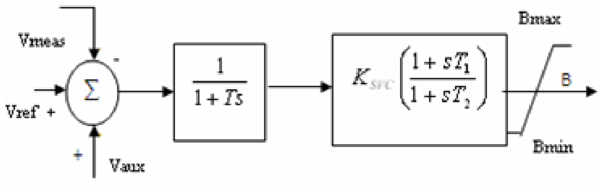

Figure1. Block representation of SVC control

III. Review Of Fuzzy Logic

Fuzzy set theory provides an excellent means for representing uncertainty due to vagueness in the available data or unknown behavior of a system. It can represent the human control processes and also allows experimental knowledge in adjusting the controller parameters.

1. Fuzzy sets

A fuzzy set is a collection of distinct elements with a varying degree of relevance or inclusion. If X is a set of elements, then a fuzzy set A in X is defined to be a set of ordered pairs

$$A = \{(x, \mu_A(x)\}\ x \in X \ (3)$$

Where $\mu_A(x)$ called the membership function of x in A

2. Fuzzy Inference system

With cause effect relationship expressed as a collection of fuzzy if–then rules in which the preconditions uses linguistic variables and the consequent have class labels, qualitative reasoning is performed to infer the results. In our model Mamdani inference system with product t-norm and max t-co norm is used. Here, the set of sensor input is matched against if part of each if–then rule, and the response of each rule is obtained through fuzzy implication operation. The response of each rule is weighted according to the extent to which each rule fires. The response of all the fuzzy rules for a particular output class are combined to obtain the confidence with which the sensor input is classified to that fault class.

3. Defuzzification

The output of a fuzzy rule based system is generally imprecise and fuzzy. As a fuzzy set cannot directly be used to take the decisions, the fuzzy conclusions of rule based systems have to be converted in to precise quantity. This is called Defuzzification. There are various methods like centroid method, weighted average method and max-membership method etc for this purpose.

4.FLC based damping controller design

Figure 2 shows the schematic diagram of a SVC along with fuzzy logic based damping controller. Generator speed deviation (Δω) and (ΔP) are taken as the input signals of the fuzzy controller. The number of membership functions for each variable determines the quality of control which can be achieved using fuzzy logic controllers. In the present investigation, five membership functions are defined for the input and output variables.

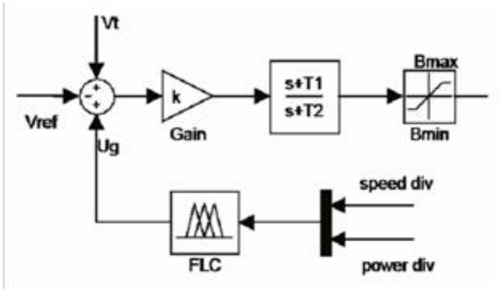

Figure 2. Block diagram of proposed Fuzzy logic controller

Figure 3 shows the membership functions defined. The mentioned membership functions are used to specify a set of rules called a rule base. The rules developed are based on the knowledge and experience. With two inputs and five linguistic terms, 25 rules were developed which is given in Table 1. In inference mechanism all the rules are compared to the inputs to determine which rules apply to the current situation. After the matching process the required rules are fired. The controlled output Bsvc is determined for the different input conditions. The defuzzification produces the final crisp output of FLC with the fuzzified input. Centroid method is employed where the output will be calculated as

$$OIP = \frac{\sum_{j=1} bi \int \mu_i (x)}{\sum_{i=1} \int \mu_i (x)}$$

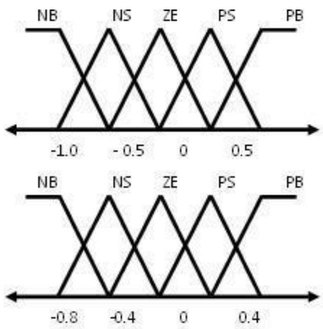

Figure 3 . Membership functions of Δω, ΔP and Bsvc

Table 1 Fuzzy Inference Rules

O.P signal

PB		PS	ZE	NS	NB	PB
	ENS	NB	NS	NB	NB	E
	PSZE	ZE	NB	NS	NS	PS
	PSPS	ZE	ZE	NS	ZE	PS
	PSPS	PS	ZE	ZE	PS	PS
PB	PS	PS	PS	ZE	PB	PB

IV. Case Study

To assess the effectiveness of the proposed controller simulation studies are carried out for the most severe fault conditions and overload conditions in both SMIB system and Multi machine system the details of the simulation are presented here.

1. SMIB System

The A single machine-infinite bus (SMIB) system is considered for the present investigations. A machine connected to a large system through a transmission line may be reduced to a SMIB system, by using Thevenin's equivalent of the transmission network external to the machine. Because of the relative size of the system to which the machine is supplying power, the dynamics associated with machine will cause virtually no change in the voltage and frequency of the Thevenin's voltage E_B (infinite bus voltage). The Thevenin equivalent impedance shall henceforth be referred to as equivalent impedance (i.e.R_e+jX_e). A SMIB system, equipped with Generator, Transmission line and SVC at the midpoint of the line is shown in Figure 4 the SVC with its controller is place at the midpoint of the transmission line. The fuzzy damping controller for the SVC is developed using MATLAB / SIMULINK.

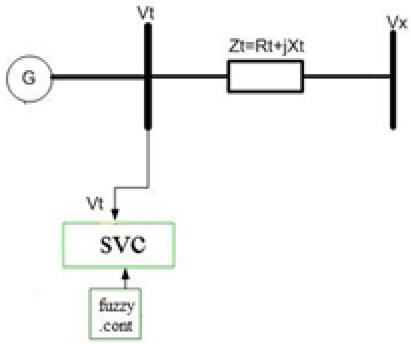

Figure 4. A single machine-infinite bus (SMIB) system

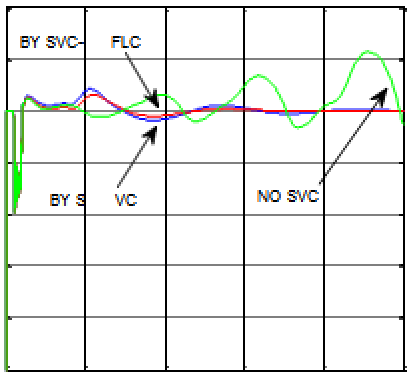

Figure 5. Terminal voltage for FLC- SVC

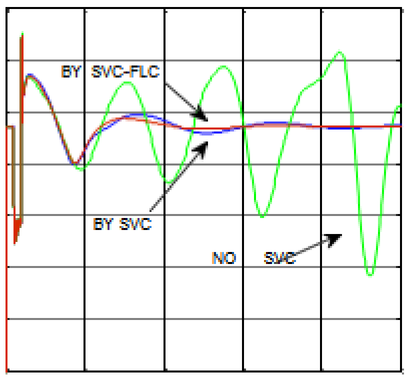

Figure 6. Line power for FLC- SVC

2. Multi machine system

The same SVC controller with FLC is implemented in two area 4 machine system (WSCC system). The one line diagram of WSCC system is given Figure 9. Power system data is given in [8].

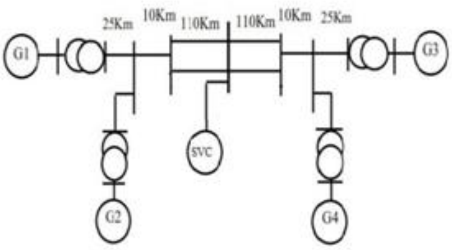

Figure 7. Two area 4 machine system

The FLC based SVC is installed at bus7 of the transmission line. With the initial power flow conditions, a three phase to ground short circuit was simulated near bus 7. In this study case, fault condition at 0.3 seconds, existing for the period of 0.1 second and cleared at 0.4 seconds. From Figures 10-13 it is clear that the rotor angle damping using fuzzy controller is suitable under fault conditions with FLC-SVC.

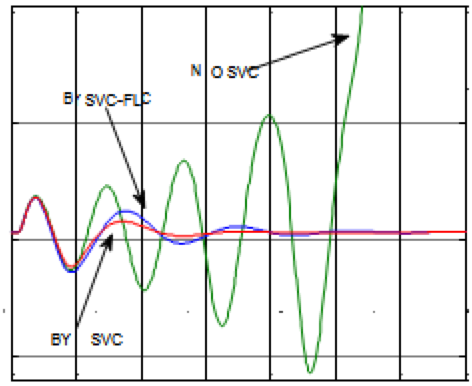

Figure 8. Angle response for FLC- SVC between G1-G2

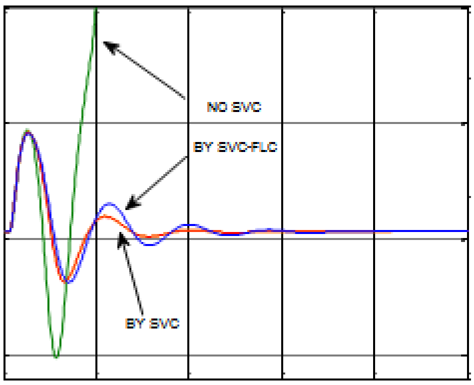

Figure 9. Angle response for FLC- SVC between **G1-G3**

V. Conclusion

This paper introduces the use of a fluffy rationale based helper control for a SVC to accomplish transient dependability upgrade. The proposed FLC for SVC is turned out to be exceptionally compelling and strong in damping power framework motions and in this manner upgrading framework transient steadiness. Fluffy guidelines are effectively gotten from the quantifiable worldwide signs like line dynamic power stream, and remote generator speed deviation. The execution of controller is examined dependent on non straight recreation results. The execution of the proposed controller is observed to be better soggy out the framework motions at quicker rate. It was additionally seen that for both SMIB framework and multi machine framework, SVC controller works precisely. Advanced PC reproductions were performed utilizing MATLAB/SIMULINK programming.

Acknowledgements

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