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Implementation of Fuzzy Logic in TCR-FC

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Abstract

TCR-FC (Thyristor Controlled Rectifier with Fixed Capacitor) is a well known combination to improve voltage stability. Supplementary signals such as variation in reactive power, variation in frequency is used to enhance the dynamic response of the system. In this paper Fuzzy logic controller is used in place of conventional controllers. Deviation in Reactive power is used as a supplementary signal. Results with conventional controller & with Fuzzy Logic controller is shown in this paper. Results have been taken with the help of MATLAB simulation & programming.

Keywords: FACTS, Reactive power deviation, Fuzzy logic Controller.

1. Introduction

Control by changing the network parameters is an effective method of improving transient stability. Flexible ac transmission system (FACTS) controllers due to their rapid response are suitable for transient stability control since they can bring about quick changes in the network parameters. Transient stability control involves changing the control variables such that the system state enters the stability region after a large disturbance. TCR-FC (Thyristor Controlled Rectifier with Fixed Capacitor) is a well known combination to improve voltage stability. Supplementary signals are used to improve dynamics of power system, i.e to reduce power oscillations etc. These supplementary signals may be deviation in Reactive power, deviation in frequency, deviation in bus angle voltage.etc. Damping of power system oscillations plays an important role not only in increasing the power transmission capability but also for stabilization of power system conditions after critical faults. In this paper deviation in reactive power is used as Supplementary signal.

2. Study System

The study system, shown in fig. 1 consists of one synchronous generator, two transformers T1 & T2, one series capacitor and a TCR-FC in the middle of line. Modeling of above system is given in [1].

Block diagram of TCR-FC is shown in fig 2. This block diagram includes firing control system and represented as a first order model having gain K and time constants T_1 and T_2.

Fig.2

Fig.1

The controller send firing control signals to the thyristor switching unit to modify the equivalent susceptance of the TCR. In fig.2 V_{meas} is bus voltage at TCR –FC bus. V_{suppl} is change in voltage due to reactive power deviation at TCR –FC bus.

3. Inclusion of Fuzzy Controller

Mamdani type Fuzzy theory is used in this paper. The number of membership functions for each variable determines the quality of control which can be achieved using fuzzy logic controllers. In the present paper, five membership functions are defined for the input and output variables. We have one input and one output. Therefore five rules were developed. The initial step in designing the Fuzzy controller is the determination of the state variables which represent the performance of the system. The input signals to the Fuzzy controller are to be chosen from these variables. The input values are normalized and converted into fuzzy variables. The expected value for each variable is found by defuzzifying the fuzzy regions. The Reactive power Deviation at the TCR is chosen as input to the Fuzzy controller and the output is the stabilizing signal. This signal is fed as one of the inputs to system.

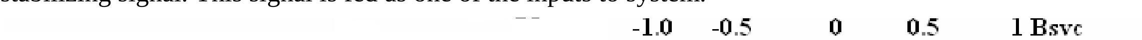

Fig.3 (Membership function of ∆ Q & ∆ B)

The proposed controller uses following linguistic variables such as: Positive Big (PB),Positive Small (PS), Zero (Z), Negative Small (NS), Negative Medium (NM) and Negative Big (NB)

4.Fault Simulation

In synchronous machine initial power is 2 pu. Suddenly it increased to 2.5 pu.

5.Results

(a) Without any supplementary controller - Voltage stability - fig 4, Rotor stability - fig 5.
(b) With Conventional controller-Voltage stability -fig 6, Rotor stability - fig 7.
(c) With Fuzzy logic Controller Voltage stability fig- 8, Rotor stability - fig 9.

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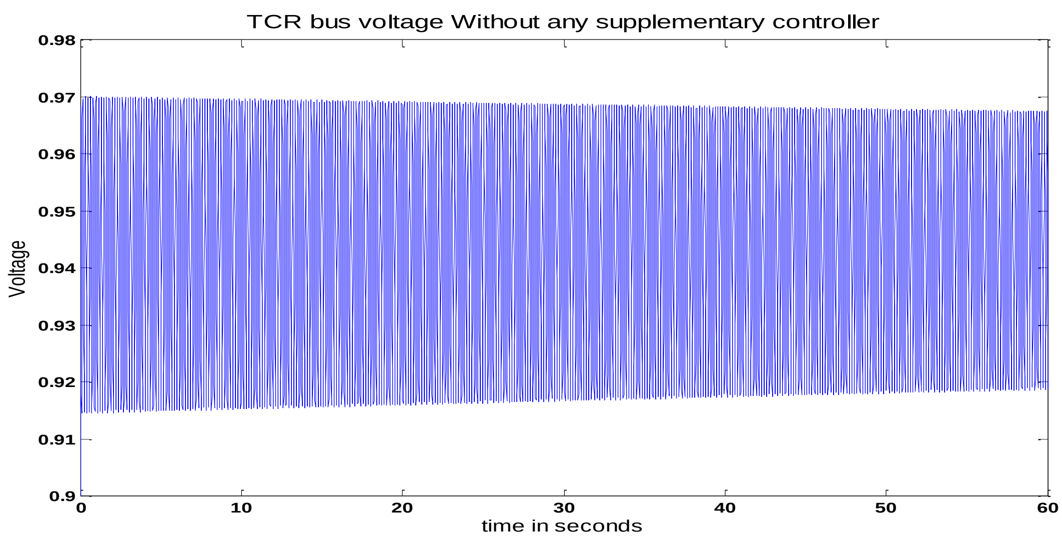

Figure 4

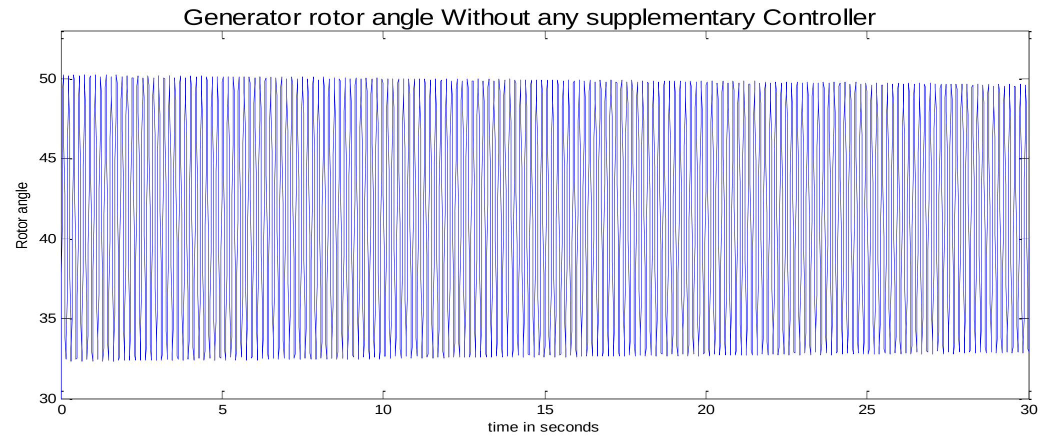

Figure 5

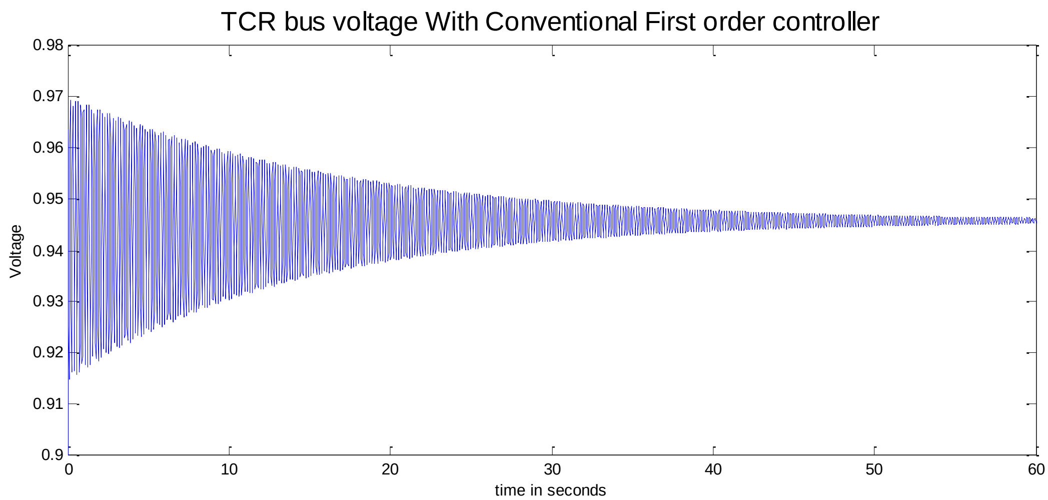

Figure 6

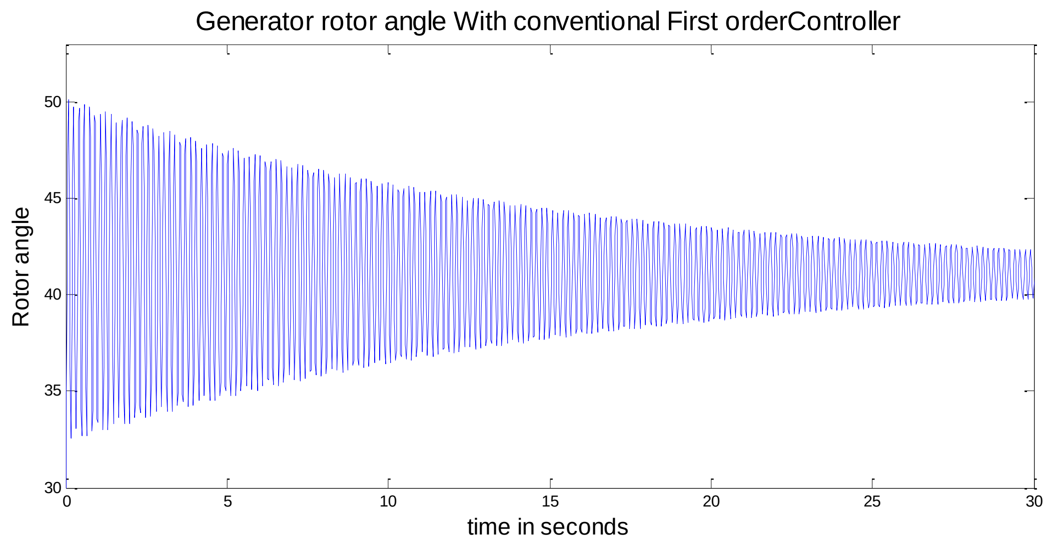

Figure 7

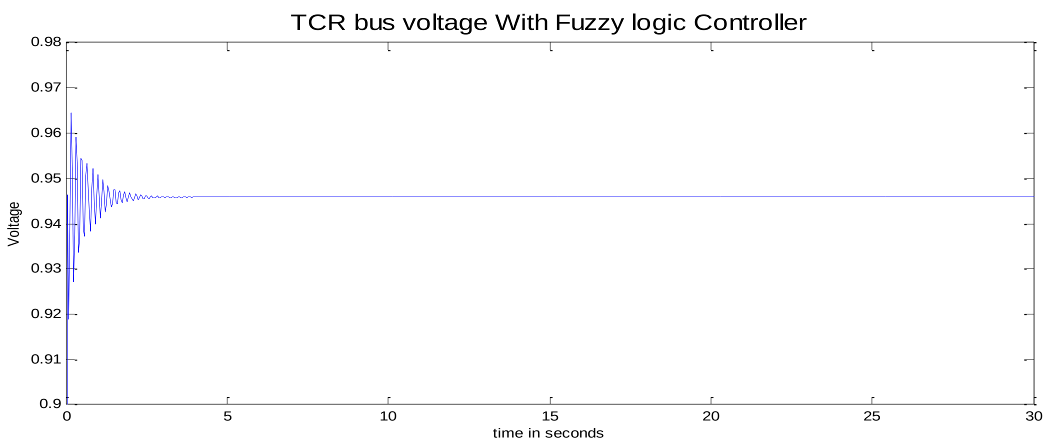

Figure 8

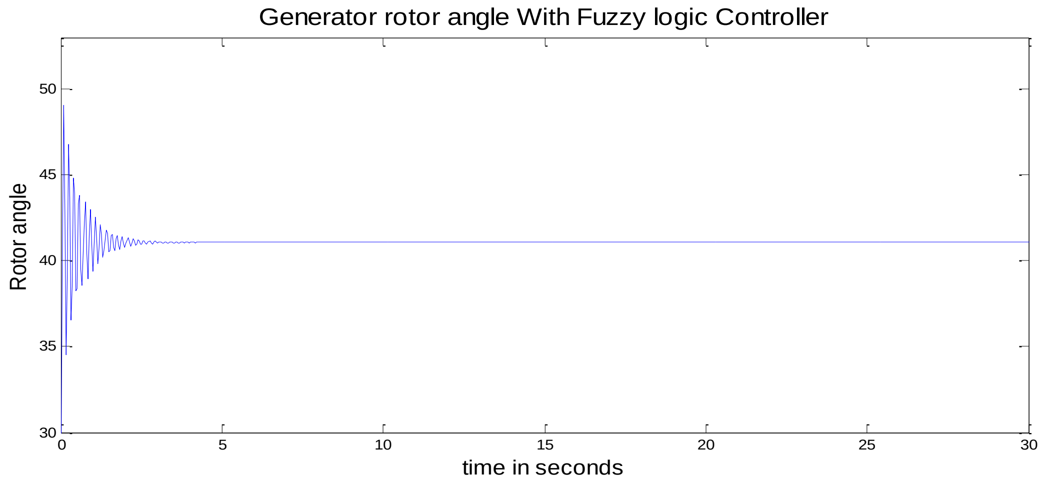
Generator rotor angle With Fuzzy logic Controller
Rotor angle
50
45
40
35
30
0
5
10
15
20
25
30
time in seconds

Figure 9