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Improvement of Power System Dynamic Stability Based on Fuzzy Logic Power System Stabilizer (FLPSS)

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Abstract. Generally this project is to improve the dynamic power system stability using fuzzy logic power system stabilizer (FLPSS) which applied to the excitation system. This research is started by electric power system mathematic modelling (state variable equation) and block diagram then set membership function of fuzzy logic power system stabilizer (FLPSS). Block diagram model (plant system) is formed from state variable equation. The plant is controlled by fuzzy logic power system stabilizer (FLPSS) which its input and output from the rotor speed and to excitation system, respectively. To observe the oscillation of dynamic power system stability, the electrical power is varied ± 0.1 pu (positive and negative value indicate an increasing and decreasing electrical power, respectively). The result shows that using FLPSS, the oscillation of dynamic power system can be improved. The overshoot of electric power and rotor speed change oscillation after the disturbance is smaller than the conventional, and also the time to reach the steady state is faster.

Introduction

Stability studying exactly and continue is needed to analyze the system, so it can work effectively. For studying dynamic stability used the model of components, as generator, transmission line, and load. The model is derived from mathematic equation, this is a linier different equation for representation of dynamic system properties, so low frequency oscillation can be stabled again by adding auxiliary excitation control [1]. The auxiliary excitation control is power system stabilizer (PSS), with input signal is rotor speed change and its signal out put is applied to the excitation system. Generally, function of the power system stabilizer is to improve the electric power system stability

Electric power system stability is a system property which probable the machine move synchronizing, for giving its reaction to a disturbance when normally worked state, then back to the beginning state if the state become normally. The electric power system stability consist of [2] :

1. Steady state stability, is an ability of electric power system for looking after synchronization, due to small disturbance, as a load fluctuation which still normal.
2. Transient stability, is an ability of electric power system for looking after synchronization, due to a large disturbance, as a short circuit, so the governor gives a reaction. The first swing of machine rotor will be formed in one minute follows the disturbance.
3. Dynamic stability, is an ability of electric power system for looking after synchronization after the first swing (period of transient stability), until the system forms a steady state, usually 1 to 1.5 minutes after disturbance.

This research is started by electric power system mathematic modelling (state variable equation) and block diagram then set membership function of fuzzy logic power system stabilizer (FLPSS). Block diagram model (plant system) is formed from state variable equation. The plant is controlled by fuzzy logic power system stabilizer (FLPSS) which its input and output from the rotor speed and to excitation system.

Research Methodology

Model of electric power system which is used in this research, based at a single machine infinite bus analysis, that is a synchronous machine which connected to an infinite bus through transmission line, shown in Fig. 1, *G* is synchronous machine, *R* and *X* are equivalent of resistance and reactance, respectively, and V_b is infinite bus voltage.

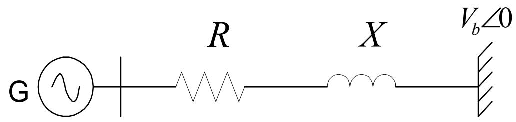


Fig. 1 A synchronous machine infinite bus

The synchronous machine infinite bus is stated in a block diagram as shown in Fig. 2 [3] :

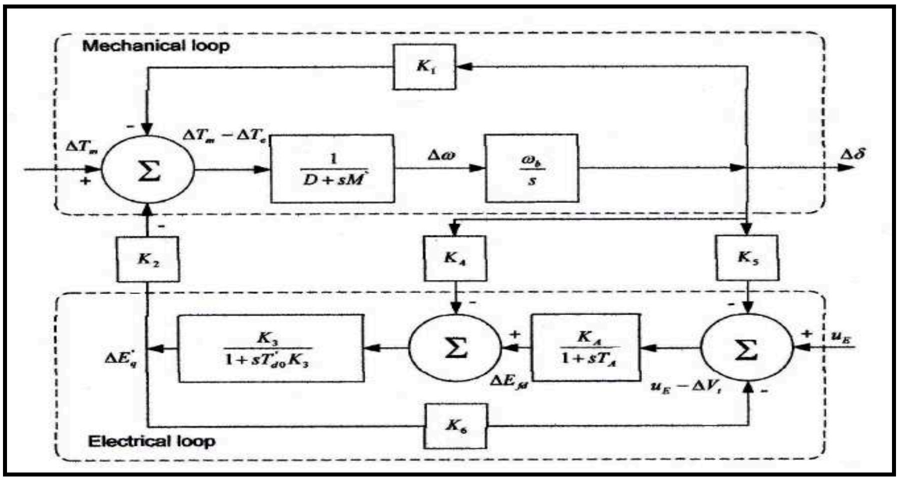


Fig. 2 Block diagram of single machine infinite bus

FLPSS will set to defined for each input and output variable. The FLPSS input has 2 input is the speed deviation and acceleration. Its output is applied to excitation system. In this project, the FLPSS is controller by 49 rules following the seven fuzzy levels, they are NB = NEGATIVE BIG, NM = NEGATIVE MEDIUM, NS = NEGATIVE SMALL, Z = ZERO, PS = POSITIVE SMALL, PM = POSITIVE MEDIUM and PB = POSITIVE BIG.

The data of electric power system as plant is taken from [4] . It consists of generator, excitation system, transmission line and infinite bus and initial condition. The research procedure can be drawn by a flow chart in Fig. 3.

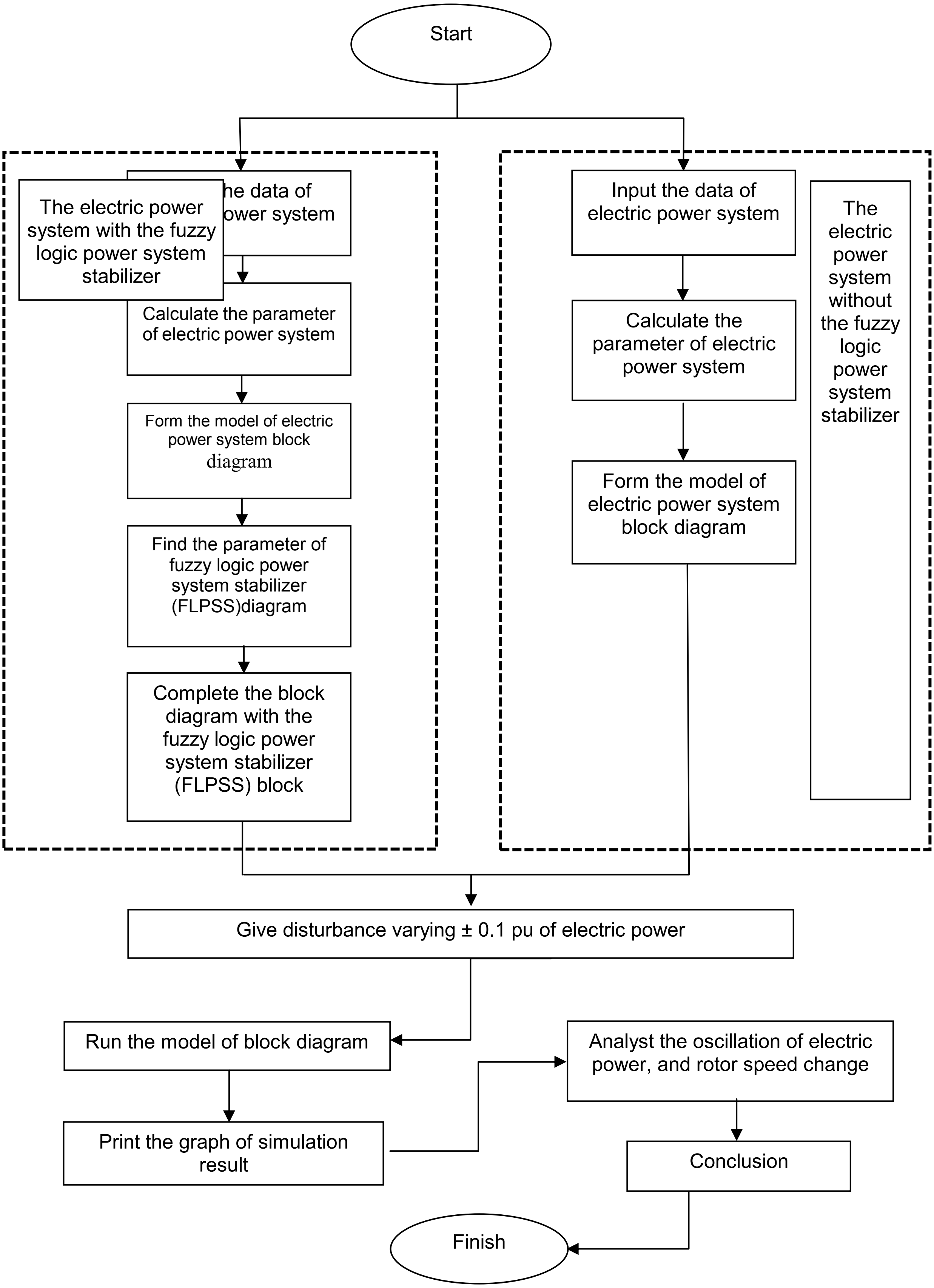
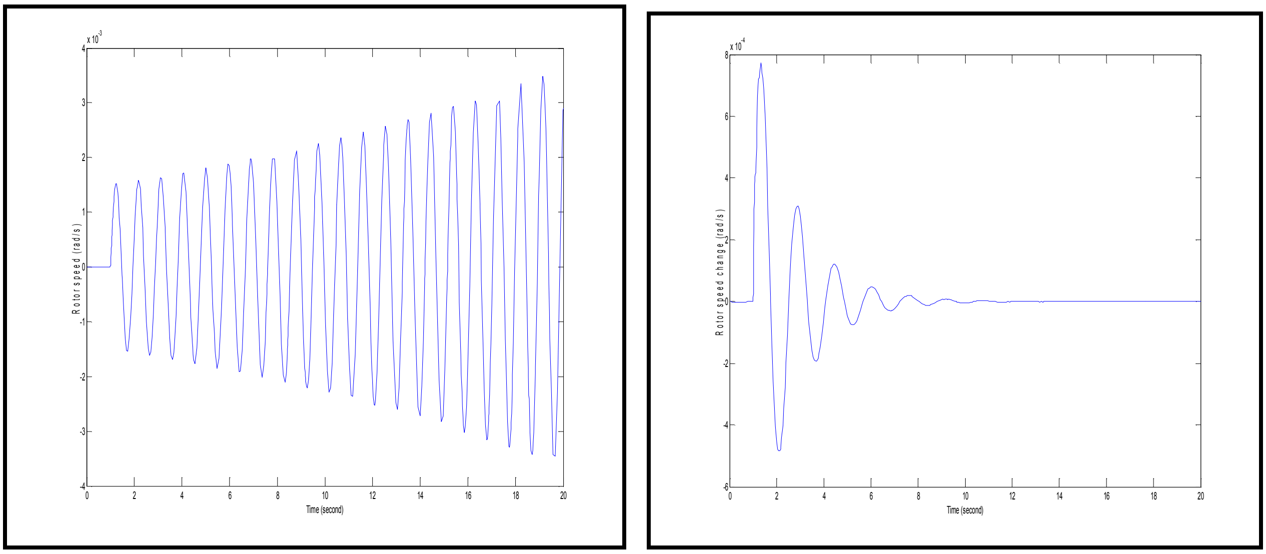


Fig. 3 Flow chart of research procedure

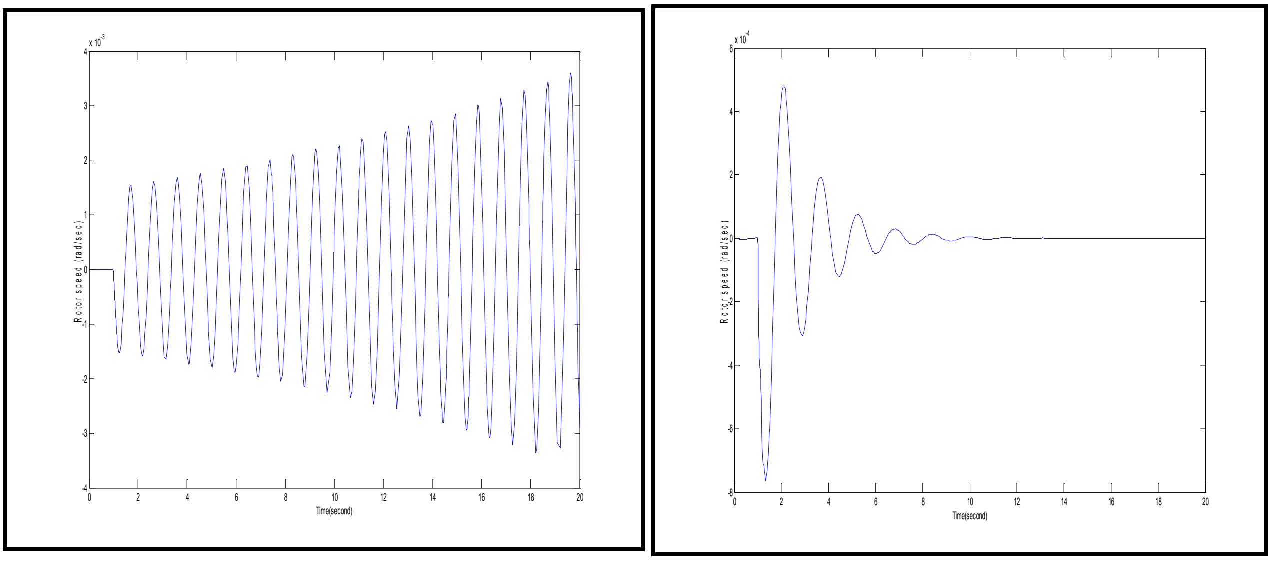
Result and Discussion

The disturbance is tested by varying ±0.1 pu of electrical power when the system operation is 1.0 second. The oscillations of dynamic power system stability are shown in Fig. 4 and 5 .



(a) Without FLPSS (b) With FLPSS

Fig. 4 Rotor speed oscillation for disturbance testing by varying +0.1 pu of electrical power



(a) Without FLPSS (b) With FLPSS

Fig. 5 Rotor speed oscillation for disturbance testing by varying -0.1 pu of electrical power

Fig 4 and 5 show that the rotor speed oscillation for disturbance testing by varying ±0.1 pu of electrical power. The rotor speed oscillation without FLPSS is not stable but with FLPSS is stable. The steady state of the rotor speed oscillation is faster with FLPSS. From the graph also can be observed that the overshoot, settling time and steady state for disturbance testing by varying the +0.1 of electrical power are 0.00077162 pu, 6.399 s and 13.7 s, respectively. When disturbance testing by varying the -0.1 of electrical power, the rotor speed get over shoot is 0.0005 rad/s, the settling time get 5.565 s and the steady state is 13.7 s.

Conclusion

The fuzzy logic power system stabilizer, though rather basic in its control proves that it is indeed a good controller due to its simplicity. The proposed controller provides a more robust control over a large excursion of the operating points versus a conventional controller.

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