Applied Mechanics and Materials Vol. 793 (2015) pp 110-113 *Submitted: 2015-02-07*
© (2015) Trans Tech Publications, Switzerland *Accepted: 2015-06-17*
doi:10.4028/www.scientific.net/AMM.793.110

Frequency Response as Tuning of Power System Stabilizer on Rotor Speed Dynamic Stability

M. Irwanto[1, a], Murina[2, b], N. Gomesh [3, c], N. Gomesh[4, d], Y.M. Irwan[5, e], M. R. Mamat [6,f], I. Muzamir[7,g], F. Malek[8,h]

[1,2,4,5,6,7,8] Centre Excellence for Renewable Energy (CERE), School of Electrical System Engineering, Universiti Malaysia Perlis (UniMAP), Malaysia

[a]irwanto@unimap.edu.my, [b]murina_murin@yahoo.com, [c]gomesh@unimap.edu.my, [d]irwanyusoff@unimap.edu.my, [f]rozailan@unimap.edu.my, [g]muzamir@unimap.edu.my,[h]mfareq@unimap.edu.my

Keywords: Power system stability, single machine infinite bus (SIMB), frequency response

Abstract. Power system stability is the ability of an electric power system unit, for giving operating conditions beginning to recover operating state of equilibrium after being subjected to a physical interference. Power system stability has been recognized as an important problem for safe operation of system unit. Stability of power system is similar to the stability of any dynamic system, and has basic mathematical. Concepts from the mathematics and theoretical stability control are first revised to provide background information related to stability of dynamic system generally and establish a connection theoretical. This paper presents to improve of dynamic power system stability using frequency response as tuning of system stabilizer. It is started by electrical power systems mathematic modeling in state variable equation then set the expertise function of frequency response as tuning of system stabilizer. The plant controlled by function of frequency response is tuned to left half plane (LHP) as system stabilizer which their input from the rotor speed. When the system occur fault, the rotor speed should be synchronized, for this case one electrical controller is needed to make sure the system is stable.

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.

In this stability study, to know that the electric power system is stable or unstable after disturbance, seen from the rotor speed, ω oscillation as stability indicator.

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.

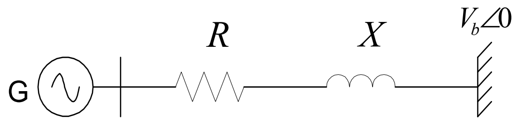

Fig. 1 A synchronous machine infinite bus

The synchronous machine infinite bus is stated in a state variable equation [3] :

$$\begin{bmatrix} \Delta\dot{\omega} \\ \Delta\dot{E}_q \\ \Delta\dot{E}_{fd} \\ \Delta\dot{\delta} \end{bmatrix} = \begin{bmatrix} -\frac{D}{M} & -\frac{K_2}{M} & 0 & -\frac{K_1}{M} \\ 0 & -\frac{1}{T'_{d0}K_3} & \frac{1}{T'_{d0}} & -\frac{K_4}{T'_{d0}} \\ 0 & -\frac{K_A K_6}{T_A} & -\frac{1}{T_A} & -\frac{K_A K_5}{T_A} \\ \omega_b & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} \Delta\omega \\ \Delta E'_q \\ \Delta E_{fd} \\ \Delta\delta \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ \frac{K_A}{T_A} \\ 0 \end{bmatrix} [u_E]$$

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. 2.

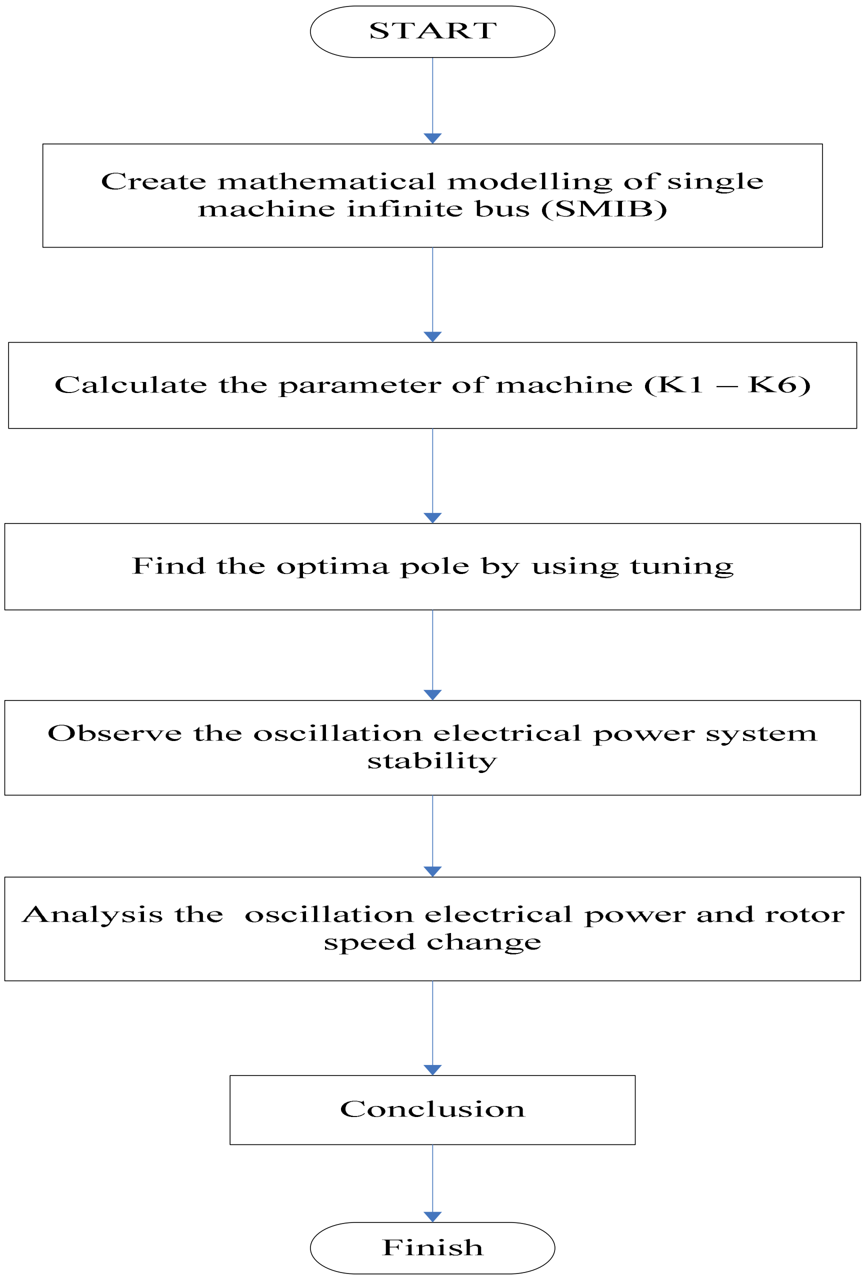

Fig. 2 Flow chart of research procedure

Result and Discussion

Fig. 3 and 4 show the rotor speed condition before frequency tuning. In this research, the data of rotor speed have been created via the M-file of MATLAB. Figure 3 shows the root locus before tuning at pole 0.4251 ± j3.3375 and -10.5320 ± j2.9497. The output will not be stable if the point pole on the right half plane (RHP). This can be seen the unstable responses in Fig. 4.

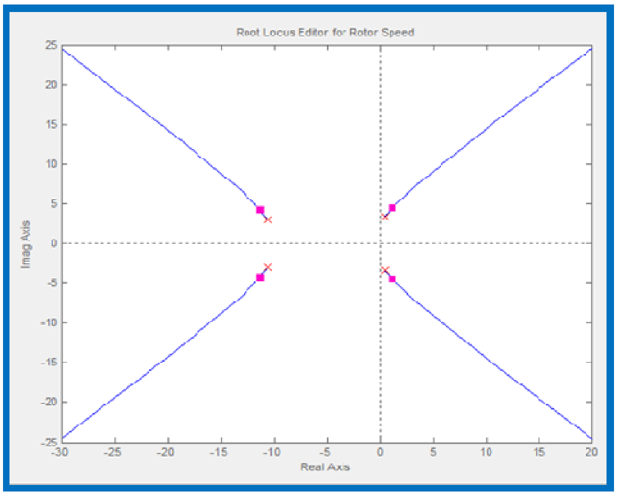

Fig. 3 Root locus of the unstable rotor speed

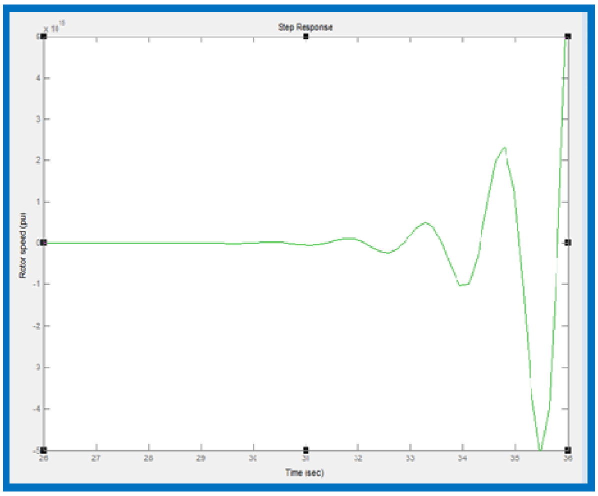

Fig. 4 Step response of the unstable rotor speed

Fig. 5 shows the root locus after tuning at pole -1.0694 ± j1.9950 and -3.6816 ± j1.9382. The output will be stable if the point pole on the left half plane (LHP). Fig. 6 show that the rotor speed after tuning obtains it settling time is 9.41s, the overshoot is begun at 0pu the maximum value are 0.684pu. The rotor speed step response is slightly becomes a steady state at 0.446pu.

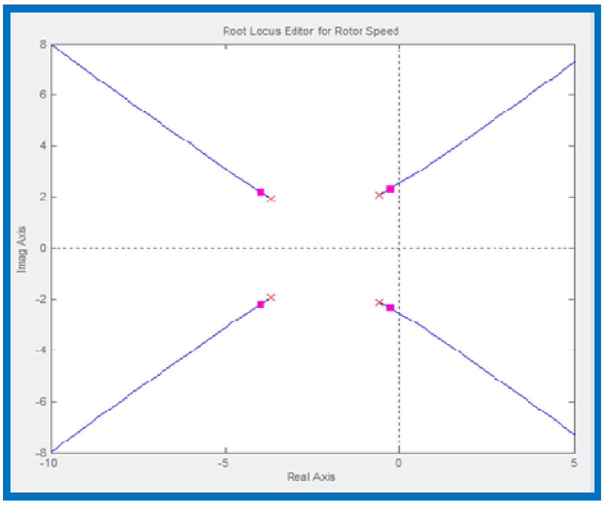

Fig. 5 Root locus of the stable rotor speed

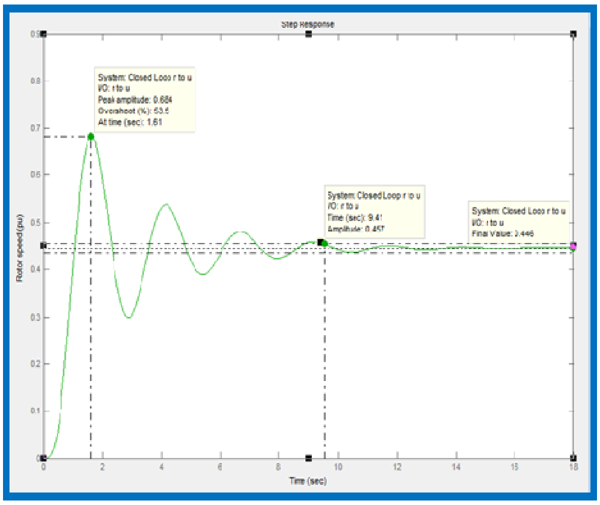

Fig. 6 Step response of the stable rotor speed

Conclusion

Based on this research, these results have been gotten by simulink Matlab. Otherwise, the comparison between before and after tuning has been proved by the simulation. The rotor speed graph whose with optimal pole has performed their steady-state which starts the time from 0s to 15.0s and slightly return down to be stable along the zero condition. This is called stability condition. The result shows that after tuning frequency element, the rotor speed can be stable. The show that the overshoot and setting time to be short.

Reference

[1] Y.Yu . *Electric Power System Dynamic*, Academic Press, New York London, 1983 pp. 65 – 94,

[2] W.D Stevenson, K. Idris. *Electrical Power System Analysis*, Erlangga, Jakarta, 1990 pp. 349-351,

[3] K.R Padiyar. *Power System Dynamis Stability and Control*, John Wiley & Sons , Singapore, 1996, pp. 191 – 268,

[4] Y. Yu. *Electrical Power System Dynamic.* New York: Academic Press, 1983, pp.65-94.