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Power System Stabilizer with Induction Motor on Inter Area Oscillation of Inter Connected

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ABSTRACT

This paper describe the problem of initializing the dynamic models of the induction motor for inter area oscillation of power system studies. To further investigate the effects of dynamic loads on power systems stability, the effectiveness of conventional as well as modern linear controllers is tested and compared with the variation of loads. The effectiveness is assessed based on the damping of the dominant mode and the analysis in this paper highlights the fact that the dynamic load has substantial effect on the system damping. This paper presents an analysis to investigate the critical parameters of the induction motor like inertia and stator and rotor resistance, and reactance which effect of the stability of the system. The examination is showed on the both a standard IEEE 10-machine system with dynamic loads. To further investigate the Power System Stabilizer with Induction Motor on Inter Area Oscillation of Inter Connected by using the MATLAB/SIMLINK Model.

KEYWORDS: *Inter Area Oscillation, Power System Stabilizer, Induction Motor Drive, and Stability.*

I. Introduction

Electric loads play an important role in the analysis of angle and voltage stability of interconnected power systems. Due to the large diverse load components, the changing load composition with time, weather and temperature, and uncertain load characteristic, it is difficult to accurately model the loads for stability studies. The stability of electromechanical oscillations and voltage oscillations between interconnected synchronous generators and loads is necessary for secure system operation because an unsecured system can undergo non-periodic major cascading disturbances, or blackouts, which have serious consequences. Power grids all over the world are experiencing many blackouts in recent years [1] which can be attributed to special causes, such as equipment failure, overload, lightning strokes, or unusual operating conditions.

The stability of electromechanical oscillations and voltage oscillations between interconnected synchronous generators and loads is required for secure system operation. Since many methods to assess the stability of power system have been proposed. An overview of power system stability where loads are constant impedance loads and dynamic loads. The induction motor loads which are considered as dynamic loads, account for large portion of electric loads, especially in large industries and air-conditioning in the commercial and residential area. The dynamic characteristics of the load affect the damping of the power systems. Power system stabilizers are extensively used in power industry to enhance the damping of power systems. In our previous work examine with rotor open circuit time constant and exciter gain .It provides better operation for power systems with constant impedance loads ,but it gets worse for power systems with the variation of dynamic loads and dynamic loads has sensitive limit the open circuit parameter. Will extend to examine the system stability with other critical parameters of induction motor like inertia and stator resistance, stator reactance, rotor resistance, rotor reactance and also improve different dynamic stability with different power system stabilizers. The main purpose of this work is to analyse the effect of dynamic loads on interconnected power systems with power system stabilizer.

The rest of the paper is organized as follows: Section II gives a brief introduction on power system model. Section III overview of small signal stability. Section IV brief introduction on Linearization of IM Equations. Section Overview of power system stabilier.Section VI gives small signal stability with IM without PSS. Section VII Gives small signal stability with IM with PSS. Section VIII, Effect of large power system with and without PSS. Induction motor parameter analysis presented on Section IX. Conclusions of the papers are summarized in Section X.

II. Power System Model

Power systems can be modelled at several different levels of complexity, depending on the intended application of the model. Fig. 1shows a 10-machine system with induction motor loads which is the main focus of this paper as the basis of this work is built up from this model.

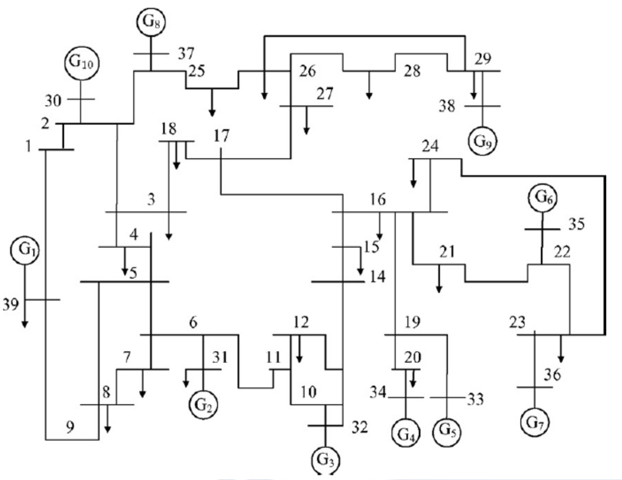

Fig 1. 10-generator, 39-bus new england system.

III. Overview of Small Signal Stability Analysis

Small signal stability is the ability of power system to maintain synchronous operation under small disturbances. In large power system, small signal stability problems may be either local or global in nature. Local modes are associated with the oscillations of generating units at a particular station with respect to the rest of system; these oscillations are localized in a small part of power system. Global modes are associated with the oscillations of many machines in one part of the system against machines in the other parts; these oscillations are also called inter-area mode oscillation. The dynamics of power system can be described by a set of nonlinear differential equations together with a set of algebraic equations as in

$$x = f(x, u)$$
$$y = g(x, u) \qquad (1)$$

Where x refers to the vector of system state variables, u refers to system input variables, y refers to system output variables, f describes the dynamics of the system, g includes equality conditions such as power flow equations of the system. In small signal stability analysis, is linearized around the system operating point:

$$\Delta x = A\,\Delta x_0 + B\,\Delta u_0$$
$$\Delta y = C\,\Delta x_0 + D\,\Delta u_0 \qquad (2)$$

Where:

$$A=\begin{bmatrix} \frac{\partial f_1}{\partial x_1} & \cdots & \frac{\partial f_1}{\partial x_n} \\ \cdots & \cdots & \cdots \\ \frac{\partial f_n}{\partial x_1} & \cdots & \frac{\partial f_n}{\partial x_n} \end{bmatrix} \qquad B=\begin{bmatrix} \frac{\partial f_1}{\partial u_1} & \cdots & \frac{\partial f_1}{\partial u_r} \\ \cdots & \cdots & \cdots \\ \frac{\partial f_n}{\partial u_1} & \cdots & \frac{\partial f_n}{\partial u_r} \end{bmatrix}$$

$$C=\begin{bmatrix} \frac{\partial g_1}{\partial x_1} & \cdots & \frac{\partial g_1}{\partial x_n} \\ \cdots & \cdots & \cdots \\ \frac{\partial g_m}{\partial x_1} & \cdots & \frac{\partial g_m}{\partial x_n} \end{bmatrix} \qquad D=\begin{bmatrix} \frac{\partial g_1}{\partial u_1} & \cdots & \frac{\partial g_1}{\partial u_r} \\ \cdots & \cdots & \cdots \\ \frac{\partial g_m}{\partial u_1} & \cdots & \frac{\partial g_m}{\partial u_r} \end{bmatrix}$$

The power system state matrix can be obtained by eliminating the vector of algebraic variables Δu_0in (2):

$$\Delta x = (A\text{-}BD^{-1}C)\Delta x_0 = A'\,\Delta x_0 \qquad (3)$$

Where A' is the system state matrix which contains all kinds of dynamic components characteristics and network connection relationship [2]-[3]. By calculating Eigen values of A', we can conclude all kinds of information about small signal stability, including a complex pair of Eigen values $\lambda = \sigma \pm j\omega$, the frequency of oscillation $f = \frac{w}{2\pi}$,and the damping ratio $\xi = \frac{-\sigma}{\sqrt{\sigma^2+w^2}}$, with σ real part of the λ,w imaginary part of the λ . σ gives the damping and w gives the frequency of oscillation. A negative real part represents a damped oscillation whereas a positive real part represents oscillation of increasing amplitude. The damping ratio ζ determines the rate of decay of the amplitude of the oscillation.

IV. Linearization of IM Equations

To represents the induction motor load in small-signal stability analysis first it has to be modelled for small-signal stability. The linearization of induction motor equations is as follows. Figure 2 shows the single line diagram of IM at load bus.

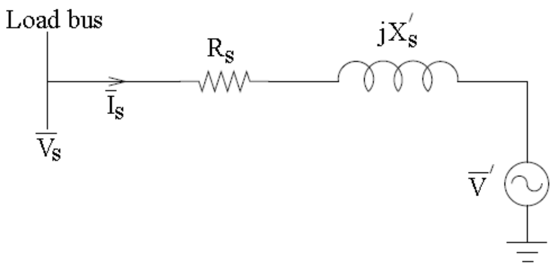

Fig2: IM model.

Linear zing the IM differential Equations, we get,

$$\Delta\dot{\underline{X}}_{im} = [A_{im}]\ \Delta\underline{X}_{im} + [B_{im}]\ \Delta\underline{V}_{im} \quad (4)$$

Where,

$$\Delta\underline{X}_{im} = \left[\Delta v'_{Q} \Delta v'_{D} \Delta\overline{w}_{r}\right]^{T}$$

$$\Delta\underline{V}_{im} = \left[\Delta v_{sQ} \Delta v_{sD}\right]^{T}$$

Using current as the output variables

$$\Delta\underline{I}_{im} = [C_{im}]\ \Delta\underline{X}_{im} + [D_{im}]\ \Delta\underline{V}_{im} \quad (5)$$

Where

$$\Delta\underline{I}_{im} = \left[\Delta i_{sQ} \Delta i_{sD}\right]^{T}$$

The non-zero elements of matrix A_{im} are

$$A_{im}(1,1) = -\left(k_2 k_3 + \frac{1}{T'_0}\right) \quad (6)$$

$$A_{im}(1,2) = \omega_B(\ 1-\overline{\omega}_{r0}) + k_1 k_3 \quad (7)$$

$$A_{im}(1,3) = -\omega_B v'_{D0} \quad (8)$$

$$A_{im}(2,\ 1) = -\ [\omega_B(1-\overline{\omega}_{r0} + k_1 k_3] \quad (9)$$

$$A_{im}(2,\ 2) = -\left(k_2 k_3 + \frac{1}{T'_0}\right) \quad (10)$$

$$A_{im}(2,3) = \omega_B v'_{Q0} \quad (11)$$

$$A_{im}(3,1) = \frac{1}{2H}[\ -k_1 v'_{Q0} + k_2 v'_{D0} + i_{sQ0}] \quad (12)$$

$$A_{im}(3,2) = \frac{1}{2H}[\ -k_2 v'_{Q0} + k_1 v'_{D0} + i_{sQ0}] \quad (13)$$

$$A_{im}(3,3) = \frac{1}{2H}[\ -mT_0(\omega_{r0})^{m-1} \quad (14)$$

The non-zero elements of matrix B_{im} are

$$B_{im}(1,1) = k_2 k_3 \quad (15)$$

$$B_{im}(1,2) = -k_1 k_3 \quad (16)$$

$$B_{im}(2,1) = k_1 k_3 \quad (17)$$

$$B_{im}(2,2) = k_2 k_3 \quad (18)$$

$$B_{im}(3,1) = \frac{1}{2H}[\ k_1 v'_{Q0} - k_2 v'_{D0}] \quad (19)$$

$$B_{im}(3,2) = \frac{1}{2H}[\ k_2 v'_{Q0} + k_1 v'_{D0}] \quad (20)$$

The non-zero elements of matrix C_{im} are

$$C_{im}(1,1) = k_2 \quad (21)$$

$$C_{im}(1,2) = k_1 \quad (22)$$

$$C_{im}(2,1) = -k_1 \quad (23)$$

$$C_{im}(2,2) = -k_2 \quad (24)$$

The non-zero elements of matrix D_{im} are

$$D_{im}(1,1) = -\ k_2 \quad (25)$$

$$D_{im}(1,2) = k_1 \quad (26)$$

$$D_{im}(2,1) = k_1 \quad (27)$$

$$D_{im}(2,2) = k_2 \quad (28)$$

V. OVERVIEW OF POWER SYSTEM STABILIZER

A PSS is designed to damp electromechanical oscillations caused by the large generator inertia and very low damping. The control objective in the PSS design is to increase the damping of the electromechanical mode by controlling the synchronous generator excitation systems using an auxiliary signal to the automatic voltage regulator (AVR). Fig. 3shows the block diagram of excitation system, including the AVR and PSS which is considered in this section.

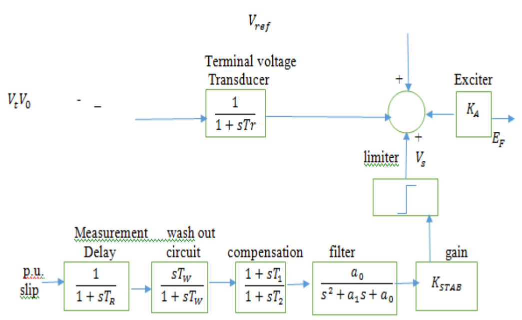

Fig3. Excitation system with AVR and PSS

The dynamics of the PSS can be described by the following two equations:

$$\dot{v}_2 = -\frac{1}{T_w}v_2 + K_{STAB}\left[-\frac{D}{2H}\omega + \frac{1}{2H}(P_m - E_q' I_{qg})\right] \quad (29)$$

$$\dot{v}_s = -\frac{1}{T_2}v_s + \frac{1}{T_2}v_2 + \frac{T_1}{T_2}\left[-\frac{1}{T_w}v_2 + K_{STAB}\left(-\frac{D}{2H}\omega + \frac{1}{2H}(P_m - E_q' I_{qg})\right)\right] \quad (30)$$

Where KSTAB is the gain of power oscillation damping controller, Tw is the time constant of the washout block, T1 and T2 are the time constants of the phase compensation block, v2 is the output of the washout block and vs is the stabilizing signal which is the output of the phase compensation block.

The parameters of the designed PSS are as follows:

$K_S = 5$	$T_R = 0.02\ s$	$T_W = 10\ s$
$T_1 = 0.1\ s$	$T_2 = 0.05\ s$	$V_{SMAX} = 0.1$
$V_{SMIN} = -0.1$	$a_1 = 35$	$a_0 = 570$

VI. Small Signal Stability with IM without PSS

The table1 shows the inter-area mode damping factor with and without PSS different Kim values. The Eigen values are in right half of the plane the system is unstable

	Inter-Area Mode WithOut PSS		
Kim	Eigenvalues	Dampting factor	Freq(Hz)
0	0.02409±3.8706i	-0.0062236	0.61602
0.1	0.01943±3.8729i	-0.0050189	0.61639
0.3	0.01064±3.8785i	-0.0027454	0.61729
0.5	0.00285±3.8855i	-0.0007358	0.6184
0.793	-0.0060±3.8973i	0.001558	0.62027

Table1. Induction motor load on inter-area mode without PSS

VII. Small Signal Stability with IM with PSS

The table2 shows the inter-area mode damping factor with and with PSS different Kim values. The Eigen value is in left-half the plane system is stable fig4 shows the variation of damping factor and frequency with Kim for inter-area mode.

	Inter-Area Mode With PSS		
Kim	Eigenvalues	Damping factor	Freq(Hz)
0	-0.28897±3.9418i	0.073114	0.62735
0.1	-0.26075±3.9351i	0.066118	0.62628
0.3	-0.20115±3.9157i	0.051302	0.6232
0.5	-0.13915±3.8864i	0.03578	0.61854
0.793	-0.05104±3.8228i	0.013351	0.60841

Table2. Induction motor load on inter-area mode with PSS

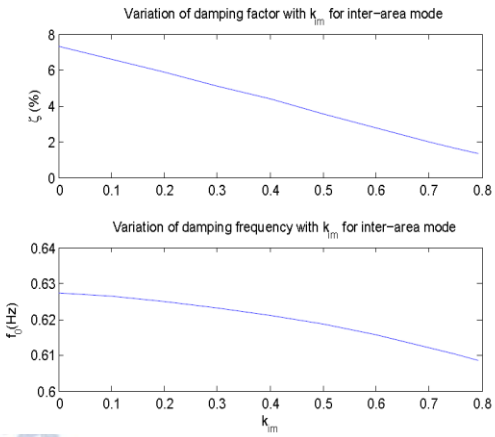

Fig4.variation of damping factor and frequency with Kim on inter-area mode.

VIII. Effect of Large Power System with and without PSS

The effect of load variation on power system stability without any controller are shown in fig5 .The designed PSS is simulated on a large power system with constant impedence loads and dynamic load.The slip_COI on 10-machine system wih PSS and without PSS as shown in fig5 and fig6.

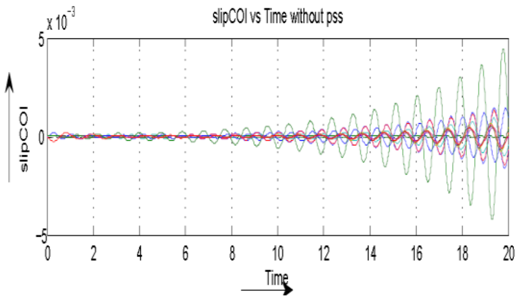

Fig5. 10-Machine slip_COI vs. time without PSS

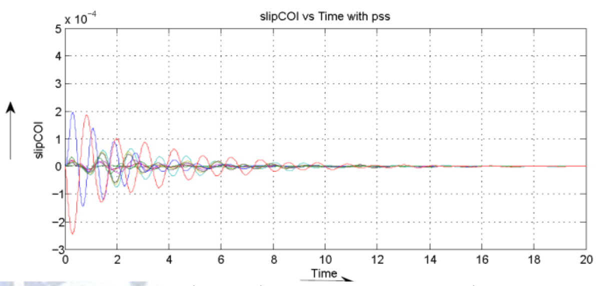

Fig6. 10-machine slip_COI vs time with PSS

IX. Induction Motor Parameter Analysis

The sensitivity of a large power system to the critical parameters is analysed in this section. For this analysis, a 10-generator, 39-bus New England system shown in Fig. 1 is considered.

In this case Kim decides the how much fraction of induction motor is used as load and remaining load is constant impedence load. Now this case study will deal how the induction motor parameters effect the small signal stability.

A. Influences of stator resistance (Rs) on inter-area mode:

The influences of Induction motor stator resistance (Rs) on small signal stability analysis are presented in table 3. The induction motor stator resistance (Rs) on damping factor (§) and frrquency (fo in Hz) for inter area mode as shown in fig7. With the increasing stator resistance, we can see that the damping factor of inter area mode decreases and frequency decreases in small range.

B. Influences of stator reactance (Xls) on inter-area mode:

The influences of Induction motor stator reactance (Xls) on small signal stability analysis are presented in table 4. The induction motor stator reactance (Xls) on damping factor (§) and frrquency (fo in Hz) for inter area mode as shown in fig8. With the increasing stator reactance, we can see that the damping factor of inter area mode increases and frequency decreases in small range.

C. Influences of (Xm) on inter-area mode:

The influences of induction motor (Xm) on small signal stability analysis are presented in table 5. The induction motorXm on damping factor (§) and frrquency (fo in Hz) for inter area mode as shown in fig 9. With the increasing Xm, we can see that the damping factor of inter area mode increases and frequency increases in small range.

D. Influences of rotor resistance (Rr) on inter-area mode:

The influences of Induction motor rotor resistance (Rr) on small signal stability analysis are presented in table 6. The induction motor rotor resistance (Rr) on damping factor (§) and frrquency (fo in Hz) for inter area mode as shown in fig 10. With the increasing rotor resistance, we can see that the damping factor of inter area mode increases and frequency decreases in small range.

E. Influences of rotor reactance (Xlr) on inter-area mode:

The influences of Induction motor rotor reactance (Xlr) on small signal stability analysis are presented in table 7. The induction motor rotor reactance (Xlr) on damping factor (§) and frrquency (fo in Hz) for inter area mode as shown in fig 11. With the increasing rotor reactance, we can see that the damping factor of inter area mode increases and frequency decreases in small range.

F. Influences of inertia of induction motor on inter-area mode:

The influences of Induction motor inertia (Him) on small signal stability analysis are presented in table 8. The induction motor inertia (Him) on damping factor (§) and frrquency (fo in Hz) for inter area mode as shown in fig 12. With the increasing inertia, we can see that the damping factor of inter area mode decreases and frequency decreases in small range.

	Inter-Area Mode		
Rs	Eigenvalues	Damping factor	Freq(Hz)
0.007	-0.20115±3.9157i	0.051302	0.6232
0.022	-0.19866±3.9134i	0.050698	0.62284
0.032	-0.19691±3.9118i	0.050275	0.62258
0.047	-0.19416±3.9091i	0.049607	0.62215
0.062	-0.19122±3.9061i	0.048896	0.62167
0.077	-0.18808±3.9027i	0.042136	0.62113

Table 3. Eigenvalue modes for different induction-motor stator resistance.

	Inter-Area Mode		
Xls	Eigenvalues	Damping factor	Freq(Hz)
0.11	-0.20115±3.9157i	0.051302	0.6232
0.15	-0.20201±3.9143i	0.051539	0.62299
0.2	-0.20355±3.9124i	0.051957	0.62267
0.3	-0.20509±3.9075i	0.053601	0.62191
0.4	-0.23±3.90631	0.052776	0.62171

Table 4. Eigenvalue modes for different induction-motor stator reactance

	Inter-Area Mode		
Xm	Eigenvalues	Damping factor	Freq(Hz)
3.62	-0.20115±3.9157i	0.051302	0.6232
4.625	-0.20119±3.916i	0.051307	0.62326
5	-0.2012±3.9161i	0.051309	0.62327
6	-0.20122±3.9163i	0.051312	0.6233
7	-0.20123±3.9164i	0.051314	0.62332
9	-0.20126±3.9166i	0.051317	0.62335

Table 5. Eigenvalue modes for different induction-motor Xm

	Inter-Area Mode		
Rr	Eigenvalues	Damping factor	Freq(Hz)
0.0062	-0.20115±3.9157i	0.051302	0.6232
0.01	-0.20047±3.9074i	0.51238	0.62188
0.02	-0.2067±3.8947i	0.052996	0.61986
0.03	-0.21664±3.8871i	0.055646	0.61866
0.04	-0.22709±3.8831i	0.58383	0.61801
0.05	-0.23684±3.8817i	0.060901	0.61779

Table 6. Eigenvalue modes for different induction-motor rotor resistance

	Inter-Area Mode		
Xlr	Eigenvalues	Damping factor	Freq(Hz)
0.07	-0.20115±3.9157i	0.051302	0.6232
0.09	-0.20156±3.9153i	0.051411	0.62313
0.1	-0.20177±3.915i	0.051469	0.6231
0.12	-0.20223±3.9146i	0.051593	0.62302
0.13	-0.20248±3.9143i	0.051659	0.62299

Table 7. Eigenvalue modes for different induction-motor rotor reactance

	Inter-Area Mode		
Him	Eigenvalues	Damping factor	Freq(Hz)
1.1	-0.20885±3.9279i	0.053096	0.62515
1.5	-0.20261±3.9182i	0.051642	0.6236
1.6	-0.20115±3.9157i	0.051302	0.6232
2.1	-0.19445±3.9028i	0.04976	0.62115
2.5	-0.18984±3.8921i	0.048719	0.61945
3.0	-0.18508±3.8783i	0.047667	0.61726

Table 8. Eigenvalue modes for different induction-motor inertia

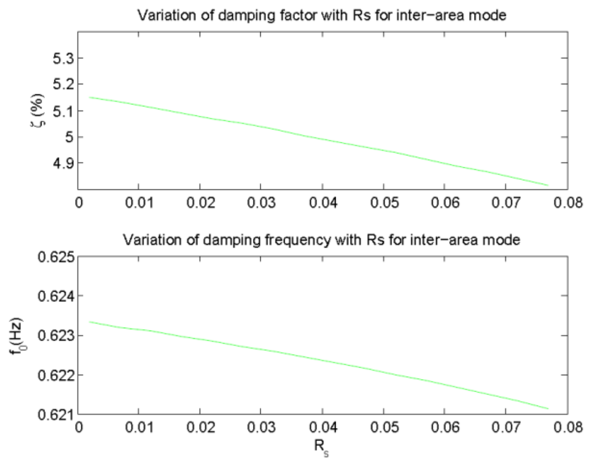

Fig7. Variation of damping factor and frequency with Rs for inter-area mode

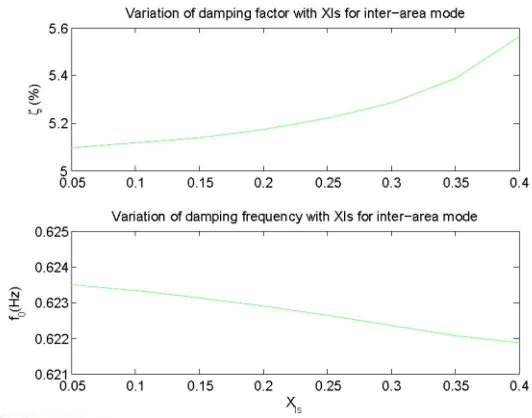

Fig8. Variation of damping factor and frequency with Xls for inter-area mode

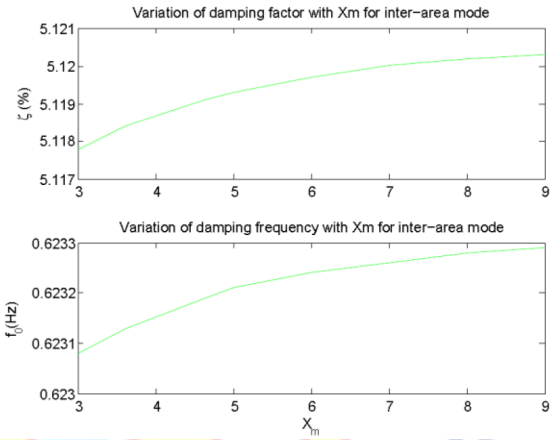

Fig9. Variation of damping factor and frequency wih Xm for inter-area mode

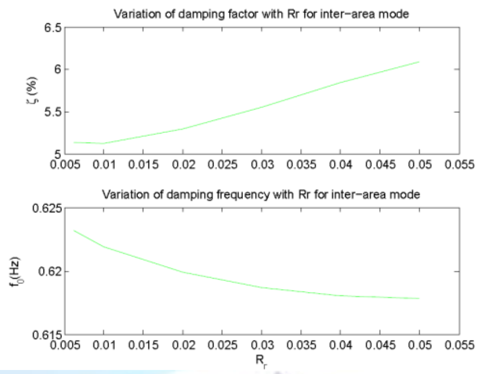

Fig10. Variation of damping factor and frequency with Rr for inter-area mode

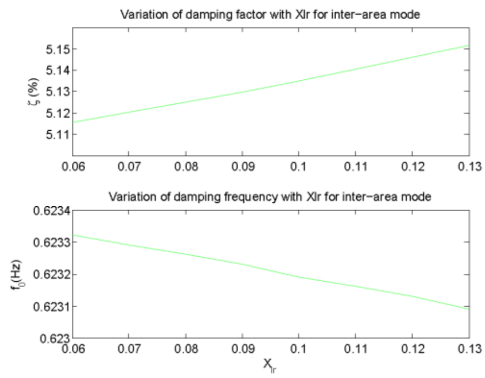

Fig11. Variation of damping factor and frequency with Xlr for inter area mode

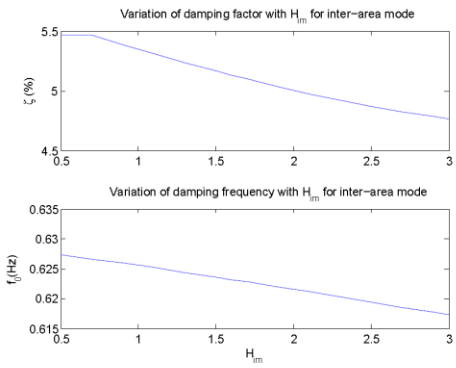

Fig12. Variation of damping factor and frequency with Him for inter-area mode.

X. Conclusion

To investigate the effects of dynamic loads on power system stability, the linearized model of the synchronous machine and induction motor system is presented in this paper. Since most of the nonlinearities in the system occur due to the interconnections, therefore the effects of interconnections are also considered in the linearization process. Then by using the concept of eigen values and participation factors and by varying some elements of the state matrix, the direct-axis open-circuit time constant of the induction motor, T'_{dom} is found as the parameter that affects the stability of the system and the system stability with other critical parameters of induction motor like inertia and Xm ,stator resistance, stator reactance, rotor resistance, rotor reactance and also improve different dynamic stability with power system stabilizer (PSS). The performance inferred using the Eigen analysis can be verified through time domain simulation without any requirement of preparing the data files separately.

References

[1] P. Kundur, "Power System Stability and Control", McGraw-Hill Inc., New York, 1994.
[2] Mr. Yadi Ananthola and Dr. K. N. Shubhanga, "Manual for A Multi-machine small- Signal Stability Programme",www.ee.iitb.ac.in/peps/downloads.html
[3] K.R. Padiyar, "Power System Dynamics - Stability and Control", Interline Publishing Ltd., Bangalore, India 1996.
[4] P.W. Sauer and M.A. Pai, Power System Dynamics and Stability, Prentice Hall, Upper Saddle River, New Jersey, 1998.
[5] Karlsson, D.; Hill, D.J.; Modelling and identification of nonlinear dynamic loads in Power systems IEEE Transactions on Power Systems Vol. 9(1): 157 166, 1994.
[6] G. Shackshaft, O.C. Symons, and J.G. Hadwick. General-purpose model of power System loads. Proc. IEE, Vol. 124(8), August 1977.
[7] P S R Murty, "Load modelling for power flow solutions", J Inst Eng. (India) Electr .Eng Div., 58 pt EL3, pp. 162-165, December 1977.
[8] IEEE Committee Report, "Standard load models for power flow and dynamic performance simulations IEEE Trans. on Power Systems, Vol. 10, No. 3, pp. 1302-1313, August, 1995.
[9] M. Y. Akhtar, Frequency-dependent dynamic, representation of induction-motor Load. Proc.IEE, Vol. 115, No. 6, JUNE 1968,pp. 802-812.
[10] M. Y. Akhtar, Frequency-dependent power system static-load characteristics. IEEE Trans PAS 110 9 (1968), pp. 13071314.
[11] T. V. Cutsem and C. Vournas"Voltage Stability Electric of Power Systems" Academic pub. Boston, 1998.
[12] R. C. Bansal, T. S. Bhatti "Small signal analysis of isolated Hybrid power Systems: Reactive power and frequency control analysis"-NEW DELHI: Narosa, 2008
[13] B. C. Lesieutre, P. W. Sauer and M. A. Pai, "Sufficient conditions on static load Models for network solvability", Proceedings of the Twenty-Fourth Annual North American Power Symposium, Reno, NV, Oct. 5-6, 1992, pp-262-271.
[14] B. C. Lesieutre, "Network and load modelling for power system dynamic analysis", Technical Report PAP-TR 93-2, Dept. of Electrical & Computer Engineering, University of Illinois at Urbana-Champaign, Urbana, IL,Jan. 1993.
[15] D.S.BRERETON, D.G.LEWIS, and C.C. YOUNG, "Representation of Induction Motor Loads in system stability studies," AIEE Transactions, Vol.76, 1957, pp. 451-460.
[16] M.M. Abdel Hakim and G.J. Berg, Dynamic single-unit representation of induction Motor groups, IEEE Trans. Power Appar.Syst., PAS-95 (1) (Jan./Feb. 1976).
[17] M. Akbaba and S.Q. Fakhro, New Model for single-unit representation of induction Motor loads, including skin effect, for power system transient stability studies, IEE Proc.-B, 139 (6) (Nov. 1992).
[18] G.J. Rogers, J. Di Manno and R.T.H. Alden, An aggregate induction motor model For industrial plants, IEEE Trans. Power Appar. Syst., PAS-103 (4) (April 1984).
[19] A.H.M.A. Rahim and A.R. Laldin, Aggregation of induction motor loads for transient Stability studies, IEEE Trans. Energy Conv., EC-2 (1) (March 1987).
[20] [20] M. Taleb, M. Akbaba and E.A. Abdullah, Aggregation of induction machines for power system dynamic studies, IEEE/PES 1994 Winter Meet., New York, New York, Jan. 30-Feb. 3, 1994.
[21] D.C. Franklin and A. Morelato, Improving dynamic aggregation of induction motor Models, IEEEjPES 1994 Winter Meet., New York, New York, Jan. 30-Feb. 3, 1994.

[22] Byoung-Kon Choi, Hsiao-Dong Chiang, Yinhong Li, Yung-Tien Chen, Der-Hua Huang, and Mark G. Lauby, “Development of Composite Load Models of Power Sys- Tems using On-line Measurement Data”, IEEE 2006.
[23] J. C. Das, Effects of momentary voltage dips on the operation of induction and Synchronous motors, IEEE Transactions on Industry Applications, vol. 26, no. 4, July/Aug 1990, pp. 711718.
[24] M. J. Bollen, The influence of motor reacceleration on the voltage sags, IEEE Transactions on Industry Applications, vol. 31, no. 4, July/Aug 1995, pp 667674
[25] J. C. Gomez, M. M. Morcos, C. Reineri, and G. Campetelli, Induction motor behaviour under short interruptions and voltage sags, IEEE Power Engineering Review, Feb 2001, pp. 11-15.
[26] G. W. Bottrell and L. Y. Yu, Motor behaviour through power system disturbances, IEEE Transactions on Industry Applications, vol. 16, no.5, Sep/Oct 1980, pp. 600604.
[27] IEEE Task Force on Load Representation for Dynamic Performance, Load representation for dynamic performance analysis, IEEE Transaction on Power Systems, vol.8, no. 2, May 1993, pp 472482
[28] M.A.Mahmud, M.J.Hossain, H.R.Pota Effect of Large Dynamic Loads on Power Systems Stability, 2012.