World Academy of Science, Engineering and Technology
International Journal of Energy and Power Engineering
Vol:8, No:11, 2014

Assessment Power and Frequency Oscillation Damping Using POD Controller and Proposed FOD Controller

Yahya Naderi, Tohid Rahimi, Babak Yousefi, Seyed Hossein Hosseini

Open Science Index, Energy and Power Engineering Vol:8, No:11, 2014 publications.waset.org/10000132.pdf

Abstract**—**Today's modern interconnected power system is highly complex in nature. In this, one of the most important requirements during the operation of the electric power system is the reliability and security. Power and frequency oscillation damping mechanism improve the reliability. Because of power system stabilizer (PSS) low speed response against of major fault such as three phase short circuit, FACTs devise that can control the network condition in very fast time, are becoming popular. But FACTs capability can be seen in a major fault present when nonlinear models of FACTs devise and power system equipment are applied. To realize this aim, the model of multi-machine power system with FACTs controller is developed in MATLAB/SIMULINK using Sim Power System (SPS) blockiest. Among the FACTs device, Static synchronous series compensator (SSSC) due to high speed changes its reactance characteristic inductive to capacitive, is effective power flow controller. Tuning process of controller parameter can be performed using different method. But Genetic Algorithm (GA) ability tends to use it in controller parameter tuning process. In this paper firstly POD controller is used to power oscillation damping. But in this station, frequency oscillation dos not has proper damping situation. So FOD controller that is tuned using GA is using that cause to damp out frequency oscillation properly and power oscillation damping has suitable situation.

Keywords**—**Power oscillation damping (POD), frequency oscillation damping (FOD), Static synchronous series compensator (SSSC), Genetic Algorithm (GA).

I. INTRODUCTION

POWER and frequency oscillations are common dynamic phenomenon which can effect on power system, especially in multi area system. To establish a reliable and secure power system, a large portion of power transmission capacity is not used. This strategy based on power system stability margin. A logic approach is increasing the power system damping to achieve rapidly diminishing power and frequency oscillation [1]. An initial and popular idea for increasing damping is using power system stabilizer (PSS) [2]. A traditional PSS, however, can compensate local oscillation mode and cannot damp out all oscillation modes. To date, most major electric power system plants in many countries are equipped with PSS. However, PSSs suffer a drawback of being liable to cause great variations in the voltage profile and may not be able to suppress oscillations resulting from serve disturbances, particularly those three phase short circuit, which may occur at the generator terminals [3], [4].

Recent progress of power electronic device introduces the Flexible AC transmission Systems (FACTs) controller in power system. FACTs controllers can control the network condition in very fast time. In other words, FACTS Controllers are power electronic based controllers which can influence transmission system voltages, currents, impedances and/or phase angles rapidly [5], [6]. This unique feature of FACTs controller can be used to improve stability of a power system [7]. Many FACTS devices connected in shunt, series, and series-shunt configurations with or without a (magnetic and/or superconductive) storage element have been proposed and implemented [8], [9]. Nowadays, series FACTS controllers demonstrate superior and competitive features to improve Power Oscillation Damping (POD) [10]. One of these advanced solid-state series controllers is Static synchronous series compensator (SSSC) [11] that is one of the important members of FACTs device family. The application of SSSC is investigated later. Power oscillation damping, stability enhancement, and frequency stabilization are studied in [12]-[14]. The influence of degree of compensation and mode of operation of SSSC on small disturbance and transient stability is also reported in the previous papers [15], [16]. Most of the mentioned papers based on small disturbance analysis that require linear model of system involved. But, linear methods cannot properly capture complex dynamics behavior of power systems, especially when major disturbance (such as three phase fault) occurs. The conditions resulting from major fault occurring provide problems. The controller that tuned to provide desired performance at small signal condition, do not guarantee acceptable performance in the event major disturbances. Future, unbalanced fault analyze cannot be studied using the single phase model. So in this paper non-linear models for SSSC and power system are considered. For this purpose, the model of multi-machine power system with SSSC controller is developed in MATLAB/SIMULINK using Sim Power System (SPS) blokes.

In these recent years, many papers have been discussed and found optimum location and proper feedback signal for PSS and FACTs device to have maximum effect on power system performance. The published papers show important of proper control signal for PSS and especially FACTs device. In [17], damping out power oscillation by using POD controller to control SSSC injected voltage. This method improves power oscillation damping. But frequency oscillation is not

Yahya Naderi, Tohid Rahimi, Babak Yousefi and Seyed Hossein Hosseini are with Tabriz University, Electrical and Computer Engineering Faculty e-mail: Y.Naderi@tabrizu.ac.ir, rahimitohid@yahoo.com, babak_yousefi@hotmail.com, hosseini@tabrizu.ac.ir.

considered. Nowadays, electric power systems are undergoing drastic deregulation. Under this situation, any power system controls such as frequency control etc. will be served as ancillary services. Especially, in the case that many Independent Power Producers (IPPs) which have insufficient abilities of frequency control tend to increase significantly. In [18], A novel graphical representation of series resonance condition when SSSC is incorporated in the system is presented and analyzes the sub synchronous resonance (SSR) characteristics of the hybrid series compensated power system in detail and proposes a simple method for the extraction of sub synchronous components of line current using filter. In [19], demonstrate the performance of the proposed schemes (SSSC and controllable series braking resistor) for improving the fault ride through capability and transient stability margin in response to severe symmetrical and asymmetrical grid faults.

The controller parameter tuning is usually complex process. In the last years, a series of classical techniques have been brought in some papers pertaining to tuning of the controller. But, the classical methods consume long time and require computation burden and have slow convergence. In addition, the search process may trap in local minimum and the solution obtained will not optimal. This situation is referred in [20]. Genetic algorithm (GA) has been popular to solving optimization problems in different application fields such as power system transient and dynamics problems. Mainly GA popularity reason is its robustness in finding an optima; solution and ability to provide a near-optimal solution close to a global minimum or maximum. There are two reasons that making GA searching for a global optimum simple [21]: 1) the Gas use multiple-point instead of a single-point search 2) GA work with the coded structure of variables instead of actual variables. GA is applied in a number of papers for optimization problems [22]. There for in this paper GA is employed to tune controller parameter.

II. THE POWER SYSTEM UNDER STUDY

A. Power System Characterize

To design and optimize the SSSC-based damping controller, a two machine system with SSSC shown in Fig. 1, is considered. The system consist of two generator divided in two subsystem and are connected via intertie. Area 1 has rating of 2100 MVA that consist of 6 machines of 350 MVA. Area 2 has rating of 1400 MVA that consist of 4 machines of 350 MVA. The load center has approximately 2200 MW consuming capacity that is modeled using a dynamic load model where the active and reactive power absorbed by the load is a function of the system voltage. The area 1 is connected to this load by two paths. L2 is 280 km and L1 is 150 km. The area 2 is also connected to the load by a 50 km line (L3). When the SSSC is bypass, the power flow towards the load center is as follow: 664 MW flow on L2, 563 MW flow on L1. The SSSC which is located at B1 is in series with line L2. Fault box is used to implementation three phase short circuit condition. Since the mentioned fault is the worst fault type, if a controller can damp out the power and frequency oscillation, the controller is proper in present of other fault. Therefore three phase short circuit is used in simulation process.

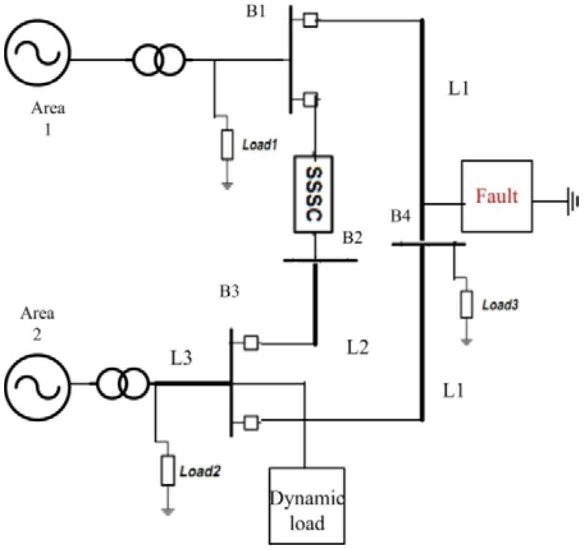

Fig. 1 Two machine power system with SSSC

Overview of SSSC and Its Control System

The synchronous voltage source (SVS)-based series compensator, called SSSC was proposed by Gyugyi in 1989 within the concept of using converter-based technology uniformly for shunt and series compensation as well as for transmission angle control [23]. The concept of using the SVS for series reactive compensation is based on the fact that SVS injects an ac voltage with the controllable magnitude and angle into the transmission line by being independent of the line current so it can rapidly change the effective reactance between the two ends of the transmission line and the power flow, whereas the compensating voltage is dependent on the line current in the series capacitor compensation case [24]. The injected voltage (Vq) is in quadrature with the line current I, and emulates an inductive or a capacitive reactance so as to influence the power flow in the transmission lines [25]. Power transmission without SSSC is expressed in (1). Existing SSSC in power system changes (1) to (2).

$$p=\frac{v^2}{x_L}\sin(\delta) \tag{1}$$

$$p=\frac{v^2}{x_L}\sin(\delta)+\frac{v}{x_L}v_{sssc}(\xi)\cos(\frac{\delta}{2}) \tag{2}$$

p : Transmission active power (pu or K/MW)
v : Line voltage (pu or k volt)
x_L : Line reactance (pu or ohm)
δ : Load angle
$v_{sssc}(\xi)$: SSSC injected voltage
ξ : chosen control parameter

Additional statement resulting from SSSC presentation can be negative or positive due to happened condition to stabilize power flow and frequency deviation. In other words, injected voltage changes the stability level. Supplementary description about SSSC structure and its control technique is brought in [26].

III. FOD, POD CONTROLLERS

A. POD, FOD Controller

The SSSC injected voltage reference is normally set by a POD (Power Oscillation Damping) controller whose output is connected to the Vqref input of the SSSC. The POD controller consists of a general gain, a low-pass filter, a washout high-pass filter, a lead compensator, and an output limiter. The input to the POD controller is power flowing in L2 (product of the bus voltage at B2 to the current flowing in L2). The POD structure is shown in Fig. 2.

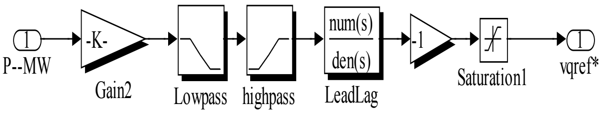

Fig. 2 POD controller structure

But the POD controller as shown in later sections cannot capture frequency oscillation. Therefore, FOD controller is another suggestion to adjust V_{qref}. Its structure consists of a gain block with gain KS, a signal washout block and two-stage phase compensation block as shown in Fig. 3. From the viewpoint of the washout function, the value of TW is not critical and may be in the range of 1 to 20 seconds [27] .The phase compensation blocks (time constants T1, T2 and T3, T4) provide the appropriate phase-lead characteristics to compensate for the phase lag between input and the output signals. The inputs to the FOD controller are speed deviations of area1 and area2 as shown in Fig. 3.

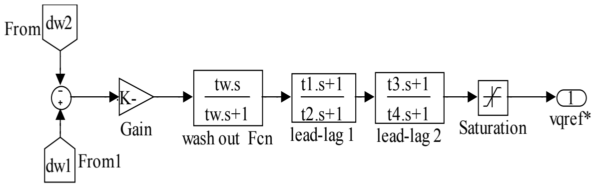

Fig. 3 FOD controller structure

FOD controller can damp out frequency oscillation, but cause power oscillation damp later than POD controller. So it is necessary reconciliation between FOD and POD performance.

B. Problem Formulation

In case of POD controller, the washout time constants TW = 1s, the low pass filter time constants =.1s, T_{num} = 1s, T_{den} = .1s, and K = .08. Proper POD controller performance with these adjusted parameter value, realize.

In case of POD controller, in the present study, TW =10s, T3 = .4272, T4 = 0.3 s are used. The controller gain KS and the time constants T1 and T3 are to be determined.

The power system oscillations are reflected in the deviations in power angle, rotor speed and line power. Minimization of any one or all of the above deviations could be chosen as the objective. In the FOD controller, an integral time absolute error of the speed deviations is taken as the objective function expressed as follows:

$$FT = \int_{t=0}^{t=t_{sim}} \left[\left|\omega_2 - \omega_1\right|\right].t.dt = \int_{t=0}^{t=t_{sim}} \left[\left|\Delta\omega\right|\right].t.dt \qquad (3)$$

FT	Fitness Function
ω_2	Area 1 speed, rad/s
ω_1	Area 2 speed, rad/s
$\Delta\omega$	Speed difference, rad/s
t_{sim}	Simulation time, s

IV. SIMULATION

The SPS toolbox is used for all simulations and SSSC-based damping controller design SPS is a MATLAB-based modern design tool that allows the user to rapidly and easily build models to simulate power systems using simulink environment. The SPS main library 'powerlib' contains models of typical power system components such as machines, governors, excitation systems, and transformers, lines and FACTS devices. The studied power system using SPS can be seen in Fig. 4.

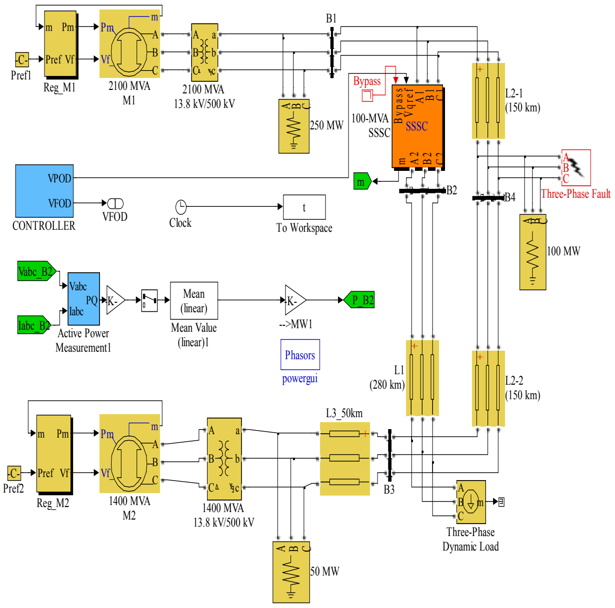

Fig. 4 The studied power system simulating using SPS

A. Application of GA Optimization Technique

Genetic algorithm (GA) has been used to solve difficult engineering problems that are complex and difficult to solve by conventional optimization methods.

The GA moves from generation to generation until a stopping criterion is met. The stopping criterion could be maximum number of generations, population convergence criteria, lack of improvement in the best solution over a specified number of generations or target value for the objective function. In this study, lack of improvement in the best solution is stopping criteria. For the aim of optimization of (3), a routine from genetic algorithm for optimization toolbox (GOAT) is used. The objective function is evaluated for each individual by simulating the example power system, considering a three phase fault. A simple flowchart of genetic algorithm is shown in Fig. 5.

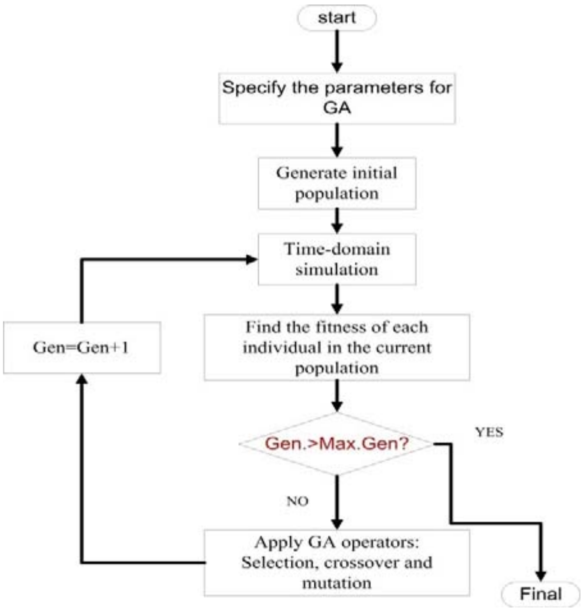

Fig. 5 Flowchart of the genetic algorithm

V. RESULT AND DISCUSSION

To assess the effectiveness and robustness of the FOD and HPFOD controllers, simulation studies are carried out for three phase fault (5cycle fault) disturbances and fault clearing sequences. In the figures, the response without control (no control) and responses with GA optimized FOD and POD SSSC-based controllers are shown.

A. POD Controller

POD can damp out power oscillation properly. This claim can be seen in Fig. 6. But frequency oscillation cannot damp quickly. Even in comparison with no controller, POD controller cause frequency oscillation more. Simulation results are seen in Figs. 6, 7.

B.FOD Controller

As discussed in section IV, TW, T3, T4 have fixed value, but T1, T2, K must be determined using genetic algorithm. So T1=.057, T2=.109, K=333.397 resulting from GA are obtained. Convergence of fitness in (3) can be seen in Fig. 8. In Fig. 8, in each step, mean and best result for each population is brought. FOD can damp out frequency oscillation properly. This claim can be seen in Fig. 9. But power oscillation cannot damp quickly. Simulation results are seen in Fig. 9, 10.

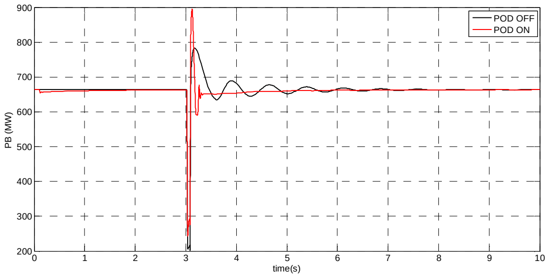

Fig. 6 Response of line power flow for a 5-cycle 3-phase fault disturbance

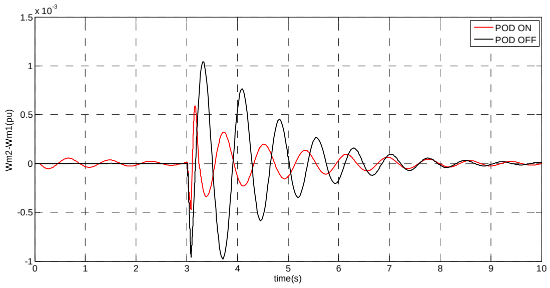

Fig. 7 Response of speed deviation flow for a 5-cycle 3-phase fault disturbance

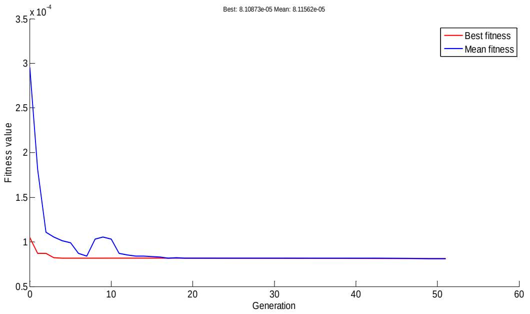

Fig. 8 Convergence of fitness function for FOD controller

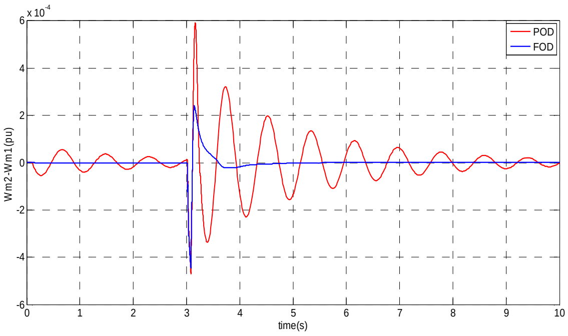

Fig. 9 Comparison of response of speed deviation for a 5-cycle 3-phase fault disturbance

World Academy of Science, Engineering and Technology
International Journal of Energy and Power Engineering
Vol:8, No:11, 2014

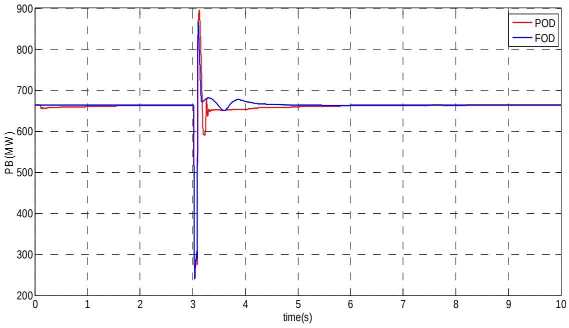

Fig 10 Response of line power flow for a 5-cycle 3-phase fault disturbance

The results are summarized in Table I.

TABLE I
COMPARISON POWER AND FREQUENCY OSCILLATION DAMPING TIME FOR THREE PHASE FAULT

Fault status controller	Frequency Oscillation before fault?	Damp time for Frequency Oscillation	Damp time for Power Oscillation
No POD	Yes	After t=10(s)	t = 8.5(s)
POD	Yes	After t=10(s)	t = 3.5(s)
FOD	No	t = 4(s)	t = 5(s)

The effectiveness of the proposed controllers to an unbalanced fault is also examined by applying one phase-ground (LG) fault near bus4. The duration of the unbalanced fault is assumed to be of 3-cycles, and the original system is restored after the clearance of the fault. The system speed deviation response for the above contingency is shown in Fig. 11, which also shows the uncontrolled response for the least severe fault i.e. LG fault. It is clear from the figure that, the system is unstable for the least severe LG fault and the proposed controllers maintain the stability of the system and also stabilizes the oscillations quickly. Further, it can be seen from Fig. 12 that the speed of power oscillation damping of the FOD controllers are quicker than no controller and slower than POD controller. The results for one phase fault are summarized in Table II. Similarly, the result for LLG fault can be seen in Figs. 13 and 14 in this state, the speed of power oscillation damping of the FOD controllers are quicker than no controller and slower than POD controller too.

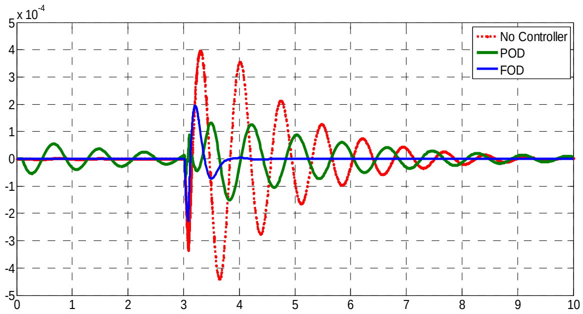

Fig. 11 Comparison of response of speed deviation for a 3-cycle under LG fault disturbance

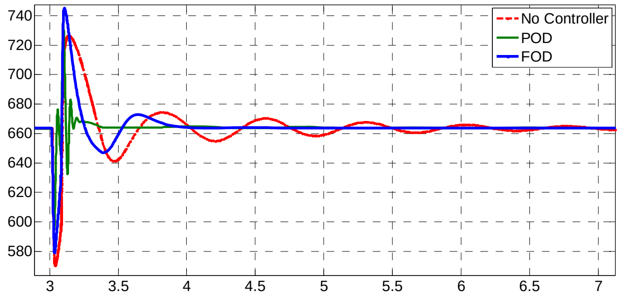

Fig. 12 Comparison of response of power oscillation for a 3-cycle under LG fault disturbance

TABLE II
COMPARISON POWER AND FREQUENCY OSCILLATION DAMPING TIME FOR LLG FAULT

Fault status controller	Frequency Oscillation before fault?	Damp time for Frequency Oscillation	Damp time for Power Oscillation
No POD	Yes	After t=10(s)	t = 6.5(s)
POD	Yes	After t=10(s)	t = 3.5(s)
FOD	No	t = 3.7(s)	t = 4(s)

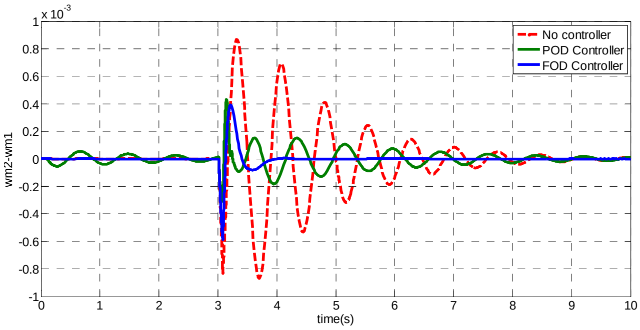

Fig. 13 Comparison of response of speed deviation for a 3-cycle under LLG fault disturbance

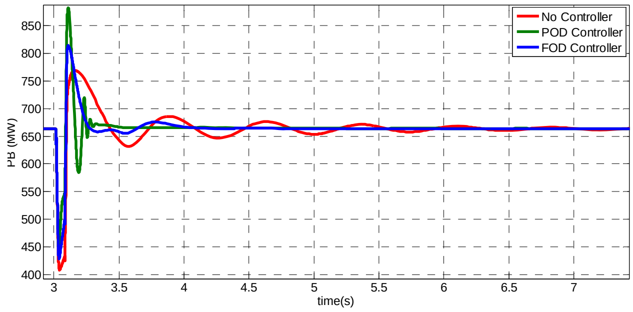

Fig 14 Comparison of response of power oscillation for a 3-cycle under LLG fault disturbance

VI. CONCLUSION

In this paper, the comparison of FOD and POD controller in multi area power system is highlighted. Firstly power control signal is chosen. Simulation result show power oscillation properly is damped (power oscillation damping time= 3.5(s)). But frequency oscillation had improper situation (after t=10(s) damping occurs). Then the genetic algorithm optimization technique is implemented to search for the optimal FOD controller parameters. The effectiveness of FOD controller to damp out frequency and power oscillation is investigated. FOD controller is damped out frequency oscillation better than POD controller (FOD happening at t=4(s)) but its ability in damping out power oscillation was not better than POD controller (power oscillation damping time= 5(s)). According to the comparison of FOD and POD controllers, altogether it seems FOD controller's performance is better than POD controller against the fault in multi area power system. Also, the effectiveness of the proposed controllers to an unbalanced fault is also examined by applying phase-ground (LG) fault and LLG fault. FOD controller damped frequency oscillation very quicker than POD controller but damped power oscillation later.

APPENDIX

A complete list of parameters used appears in the default options of SimPowerSystems in the User's Manual. All data are in P.U unless specified otherwise.

1) Generator

S_{B1} = 2100 MVA, S_{B2} = 1400 MVA, H = 3.7 s, V_B = 13.8 kV, f = 60 Hz,P_{eo}= 0.75, V_{to}= 1.0, $\delta_o = 41.51^0$, R_S = 2.8544 e -3, X_d = 1.305, $X_{d'}$ = 0.296, $X_{d''}$= 0.252, X_q = 0.474, $X_{q'}$ = 0.243, $X_{q''}$ = 0.18, T_d = 1.01 s, $T_{d'}$ = 0.053 s, $T_{qo''}$ = 0.1 s.

2) Hydraulic Turbine and Governor

Ka = 3.33, Ta = 0.07, Gmin = 0.01, Gmax = 0.97518, Vgmin = - 0.1 pu/s, Vgmax = 0.1 pu/s, Rp = 0.05, Kp = 1.163, Ki = 0.105, Kd = 0, Td = 0.01 s,β =0, Tw = 2.67 s

3) Excitation System

TLP = 0.02 s, Ka =200, Ta = 0.001 s, Ke =1, Te =0, Tb =0, Tc =0, Kf = 0.001,Tf = 0.1 s, Efmin = 0, Efmax = 7, Kp= 0

4) Transformer

2100 MVA, 13.8/500 kV, 60 Hz, R1 = 0.002, L1 = 0, D1/Yg connection, Rm = 500, Lm = 500

5) Transmission line

3-Ph, 60 Hz, R1 = 0.02546 Ω/ km, R0= 0.3864 Ω/ km, L1= 0.9337e-3 H/km, L0 = 4.1264e-3 H/ km, C1 = 12.74e-9 F/ km, C0 = 7.751e-9F/ km

6) SSSC

Snom = 100 MVA, Vnom = 500 kV, f = 60 Hz, Vqmax = 0.2, Max rate of change of Vqref = 3/s, Rcnv = 0.00533, Lcnv = 0.16, VDC = 40 kV, CDC = 375e-6 F, KP_IVR=0.00375, KI_IVR=0.1875, KP_VdcR= 0.1e-3,KP_VdcR 20e-3

REFERENCES

[1] de Mello, F. P., "Power Technol. Inc., Schenectady, NY Exploratory concepts on control of variable series compensation in transmission systems to improve damping of inter machine/system oscillations," Power Systems, IEEE Transactions on Power System, vol. 9, pp. 102-108, Feb. 1994.

[2] Gibbard, M.J., "Robust design of fixed-parameter power system stabilisers over a wide range of operating conditions," Power Systems, IEEE Transactions on Power System, vol. 6, pp. 794-800, May. 1991.

[3] B. Pal and B. Chaudhuri, Robust control in power systems, Springer Science and Business Media, Inc 2005.

[4] A.T. Al – Awami, M.A. Abido and Y.L. Abdel –Magid, "Power system stability enhancement using unified power flow controllers", Electric power energy system, 29, 2007.

[5] Y.H. Song and A.T. Johns, Flexible AC Transmission Systems (FACTS), London, Institution of Electrical Engineers, 1999.

[6] N.G. Hingorani and L. Gyugyi, Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems, New York, IEEE Press, 2000.

[7] S. Panda, N. Padhy, R. Patel., "Modelling, simulation and optimal tuning of TCSC controller. International Journal of Simulation Modelling," vol. 6 no. 1, pp. 37–48, 2007

[8] Wang, H. F., Li, M. & Swift, F. J., "FACTS-based stabilizer designed by the phase compensation method. I. Single-machine infinite-bus power systems. II. Multi-machine power systems. Advances in Power System Control, Operation and Management", Fourth International Conference on (Conf. Publ. No. 450), vol. 2, pp. 638-649,1997

[9] Chen, J., Lie, T. T. & Vilathgamuwa, D. M., "Enhancement of power system damping using VSC-based series connected FACTS controllers," IEE Proc. Generation. Transmission and Distribution., vol. 150(3), pp.353 -359,2003

[10] Wang, H. F., Swift, F. J. & Li, M. , "Selection of installing locations and feedback signals of FACTS-based stabilizers in multi machine power systems by reduced-order modal analysis, " Transmission and Distribution, IEE Proceedings, vol. 144, pp. 263-269,1997

[11] Kazemi, A., Ladjevardi, M. & Masoum, M. S. (2005), "Optimal selection of SSSC based damping controller parameters for improving power system dynamic stability using genetic algorithm" Iranian Journal of Science and Technology, Transaction B, 29(B1), 1-10.

[12] D. Menniti, A. Pinnarelli, N. Scordino and N. Sorrentino, "Using a FACTS device controlled by a decentralised control law to damp the transient frequency deviation in a deregulated electric power system" Electric Power Systems Research, vol. 72 pp. 289–298, 2004.

[13] I. Ngamroo, J. Tippayachai and S. Dechanupaprittha, "Robust decentralised frequency stabilisers design of static synchronous series compensators by taking system uncertainties into consideration" Electrical Power and Energy Systems vol. 28, pp. 513–524, 2006.

[14] F. A. R. Al Jowder and B. T. Ooi, "Series Compensation of Radial Power System by a Combination of SSSC and Dielectric Capacitors," IEEE Transactions on Power Delivery, vol. 20, no. 1, pp. 458-465, January 2005.

[15] F. A. R. Al Jowder, "Influence of Mode of Operation of the SSSC on the Small Disturbance and Transient Stability of a Radial Power System," IEEE Transactions on Power Systems, vol. 20, no. 2, pp. 935-942, May 2005.

[16] C. Udhayashankar, Princy Zachariah, Rani Thottungal, N. Nithyadevi, "SSSC Based Voltage Control and Power Oscillation Damping of Multi-Area Power System," European Journal of Scientific Research, Vol. 87 No 4 October, 2012, pp. 479-490

[17] Y. L. Abdel-Magid and M. A. Abido, "Robust coordinated design of excitation and TCSC-based stabilizers using genetic algorithms," International Journal of Electrical Power & Energy Systems, vol. 69, no. 2-3, pp. 129-141. 2004

[18] R. Thirumalaivasan , M. Janaki and N. Prabhu "Damping of SSR using subsynchronous current suppressor with SSSC", IEEE Trans. Power Syst., vol. 28, no. 1, pp.64 -74 , 2013.

[19] El Moursi, Mohamed Shawky, Khaled Goweily, J. L. Kirtley, and Mohamed Abdel-Rahman. "Application of Series Voltage Boosting Schemes for Enhanced Fault Ride through Performance of Fixed Speed Wind Turbines." IEEE Transactions on Power Delivery, pp. 61-71, 2014.

[20] D. E. Goldberg, Genetic Algorithms in Search, Optimization and Machine Learning. Addison-Wesley, 1989.

[21] S.Mishra, P.K. Dash, P.K.Hota and M.Tripathy, "Genetically optimized neuro-fuzzy IPFC for damping modal oscillations of power system." IEEE Trans. Power Systs., vol-17, pp. 1140–1147, 2002.

[22] M.A. Abido, "Analysis and assessment of STATCOM-based damping stabilizers for power system stability enhancement," Electric Power Systems Research, vol. 73, pp. 177–185, 2005.

[23] N.G. Hingorani and L. Gyugyi, "Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems," New York, IEEE Press, 2000.

[24] Irfan Unal, "Damping Power System Oscillation Using an SSSC-Based Hybrid Series Capactive Compensation Scheme," Degree of Master of Science. Thesis, University of Saskatchewan, 2011

[25] H. F. Wang, "Static synchronous series compensator to damp power system oscillations," Electric Power Systems Research, vol. 54, pp. 113-119, 2000.
[26] M.A. Abido, "Analysis and assessment of STATCOM-based damping stabilizers for power system stability enhancement," Electric Power Systems Research, vol. 73, pp. 177–185, 2005
[27] P. Kundur. Power System Stability and Control. McGraw-Hill, New York, 1994

Yahya Naderi was born in Tabriz, Iran, 1989. Receiving his B.Sc. and M.Sc. degrees (Second Class Honors) both in Electrical Engineering Department of University of Tabriz, Tabriz, Iran, in 2011 and 2013, respectively. He is currently working as a P.hD student in electrical power engineering (power electronics and systems) with research interests including Power Electronics Converters analysis & Design, Power Quality, Multilevel Inverters, Renewable Energies, Smart Grids, Home energy management and DSM.

Tohid Rahimi was born in Salmas in the Iran, received the BS.c degree from Tabriz University, Tabriz, Iran, in 2011, and MS.c degree in electrical engineering. He is going Ph.D in Tabriz University (if God want). His interests include power system control and stability, Reliability, EMI, Power Electronic Converter, AC and DC machine drive.

Seyed Hossein Hosseini (M'93) was born in Marand, Iran, in 1953. He received the M.S. degree from the Faculty of Engineering, University of Tabriz, Tabriz, Iran, in 1976, and the D.E.A. and Ph.D. degrees from National Polytechnic Institute of Lorraine (INPL), Nancy, France, in 1978 and 1981, all in electrical engineering. In 1982, he joined the Department of Electrical Engineering, University of Tabriz, as an Assistant Professor, where he was an Associate Professor from 1990 to 1995, and has been a Professor since 1995. From September 1990 to September 1991, he was a Visiting Professor at the University of Queensland, Australia. From September 1996 to September 1997, he was a Visiting Professor at the University of Western Ontario, Canada. His current research interests include power electronic converters, matrix converters, active and hybrid filters, application of power electronics in renewable energy systems and electrified railway systems, reactive power control, and harmonics and power quality compensation systems such as static VAR compensator, unified power quality conditioner, and flexible ac transmission system devices.