

Dynamics Stability Improvement of Single Machine Infinite Bus System Installed With GAPSS

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ABSTRACT: Power system stabilizer (PSS) is used to damp out local mode oscillations of synchronous generators. PSS are usually designed to provide a proper phase lead which is load dependent. The well-known Heffron–Phillips linearized model, a commonly used model in damping control design, is employed to represent the signal machine power system. Thus, PSS parameters have to be adjusted at each operating condition. Power system stabilizer improvement of parameter tuning for Genetic algorithm are used. Finally, the simulation results of system dynamic performance response for CPSS and GAPSS parameters variation is achieved and discussed.

KEYWORDS: excitation, voltage regulator synchronous machine, Power system Stabilizer, low frequency oscillation, Damping, small signal stability, population, crossover, mutation.

I. INTRODUCTION

Power system is a dynamic system nowadays, the electric power system are not operated as isolated system, but as interconnected systems which having thousands of electrical elements and be spread over wide areas. synchronous generator is widely used in a power system as a source of electrical energy.

The power system are frequently exposed to different instabilities such as low frequency oscillations and disturbances that occur due to minor variation in load and generation which results in generator rotor angle. Excitation control is very useful for maintaining stability of power system. Excitation systems constitute the fast acting AVR. However, it produces a negative damping at higher values of system reactance high generator output. thus, it is very important to increase the damping torque in order to reduce the rotor angle oscillations. the power system stabilizer is added to damp the generator rotor oscillation by controlling its excitation by providing supplementary signal in the excitation system to damp out low frequency oscillations. The use of PSS has become very common in operation of large power system.

The conventional power system stabilizer, which use to lead lag compensation, where gain setting designed for specific operating condition is giving poor performance under different synchronous generator loading conditions. Parameter tuning of PSS for genetic algorithm are used.

II. CONVENTIONAL POWER SYSTEM STABILIZER

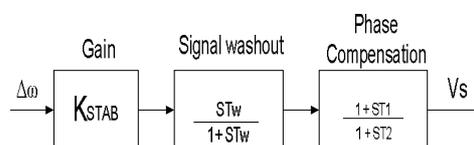


Fig.1 Basic block diagram of CPSS

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The basic function of a PSS is to add damping to the generator rotor oscillations by controlling its excitation using auxiliary stabilizing signal. To provide damping, the stabilizer must produce a component of electrical torque in phase with the rotor speed deviation. [2]

The CPSS design consists Of Stabilizer gain, signal Washout and phase compensation.

phase compensation block provides the appropriate phase lead characteristics to compensate for the phase lag between exciter input and generator electrical torque.

signal washout block serves as high pass filter, with time constant T_w high enough to allow signals associated with oscillations in ω or to pass unchanged, which removes D.C. signals. Without it, steady changes in speed would modify the terminal voltage. It allows PSS to respond only to changes in speed.

stabilizer gain KSTAB determines the amount of damping introduced by PSS. Ideally, the gain should be set at a value corresponding to maximum damping.

III. PROBLEM FORMULATION

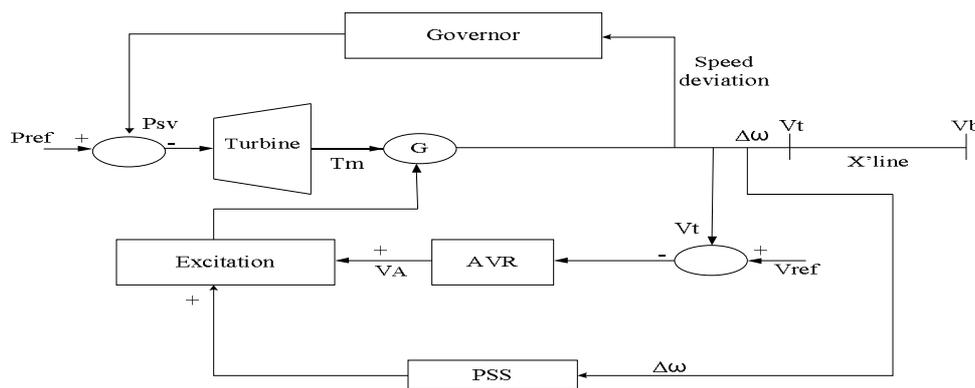


Fig. 2 Basic block diagram of power system configuration for SMIB

- 1) **Synchronous generator:** The Synchronous Generator is most common source of Electric power because it is simple to control, robust and maintenance free in a brushless system.[5]
- 2) **Turbine:** Turbine converts Kinetic energy of a steam, fuel, water into rotational energy. It works as prime mover. And thus provide mechanical input required to the Generator.
- 3) **Governor:** The job of the Governor is to maintain the speed that changes with variation in load. It provides correct amount of mechanical power input to the turbine to match the electrical output of the corresponding Generator.
- 4) **Excitation:** Excitation system provides the D.C current required for the field winding of a synchronous Generator to produce rated terminal voltage at the generator terminal.
- 5) **AVR:** Automatic voltage regulator is used to maintain a constant terminal voltage across load by varying the excitation of the field.
- 6) **PSS:** The fast acting AVR produce negative damping .Therefore PSS is used to provide additional damping to excitation control to reject the oscillations from power grid and to prevent rotor speed or angle from oscillation.

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IV. BLOCK DIAGRAM REPRESENTATION OF PSS WITH SMIB

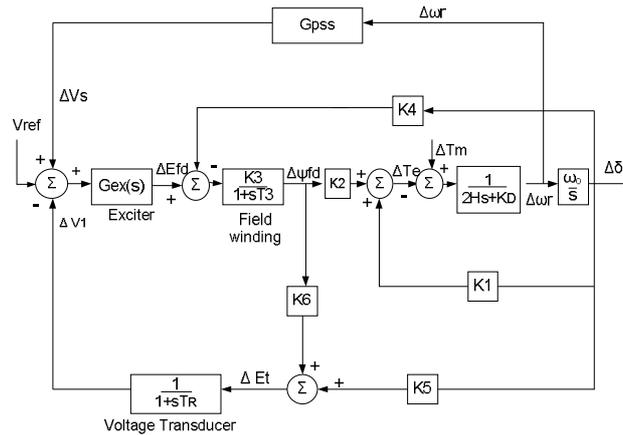


Fig.3 The block diagram representation of PSS for SMIB system

The power system under consideration is called single machine infinite bus (SMIB) system. Because only one synchronous generator is connected via a transmission line to the infinite bus. Here, K1 to K6 are Heffron Phillips constants. [18]

There are two types of loop exists namely mechanical loop and electrical loop.

Here, the mechanical loop is represented by the system inertia and the damping constant, where the input is torque balance $\Delta T_m - \Delta T_e$ and the output is incremental torque angle $\Delta \delta$. The electrical loop of the system consists of three main parts:

- 1) the composition of the electrical torque influenced by $\Delta \delta$ over constant K1 and the internal incremental voltage $\Delta e'q$ over constant K2.
- 2) The effect of the field winding determined by the field winding constant K3 and influenced by $\Delta \delta$ over constant K4 and
- 3) the effect of the excitation system influenced by $\Delta \delta$ over constant K5 and $\Delta e'q$ over constant K6. The excitation system itself is modelled by a first-order transfer function including the amplification factor KA and the time constant TA.

V. GENETIC ALGORITHM BASED PSS

Genetic algorithms are optimization technique, which is inspired by natural selection and natural genetics. It differs from other technique by providing number of candidate solution rather than one candidate solution. Each candidate solution of problem represented by individual. the process of GA is initialized with population of random guesses.

GA include operators such as reproduction , crossover , mutation, inversion. The different Genetic Algorithm parameters are listed below:

Table 1. Genetic Algorithm parameter

Population Size	10
Maximum number of Generation	50
Length of genotype	6
Crossover probability	0.8
Mutation probability	0.001

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Crossover: It is the process in which two chromosome combine their genetic material to produce a new offspring which possesses both their characteristics.

Population: It is Subset of all the possible solution of given problem.

Mutation: It is the process by which a string is deliberately changed so as to maintain diversity in the population set.

VI. SIMULATION OF PSS AND GAPSS

In this representation the dynamic characteristics of the system are expressed in terms of so called K constants. the analysis is done for three various loading conditions and according to that the value of K_1 to K_6 constant are calculated and the angle variation in speed, angular position and the electric torque are analyzed.

Case 1: $P=0.5$ and $Q=0.3$

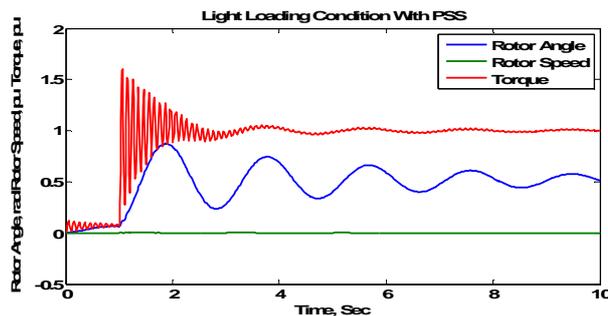


Fig.4 measurements for Light Loading Condition With PSS

Above fig.4 in the light loading condition with power system stabilizer. This case in active power 0.5 and reactive power is 0.3

Case 2: $P=1.0$ and $Q=0.5$

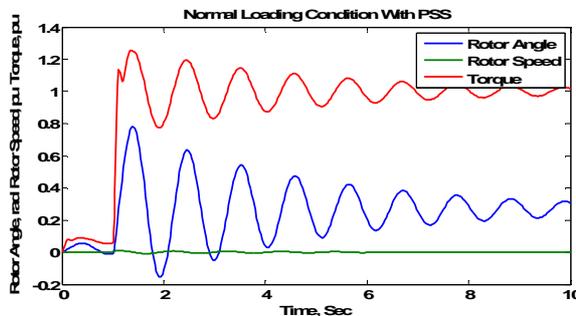


Fig.5 measurements for Light Loading Condition With PSS

Above fig.5 in the Normal loading condition with power system stabilizer. This case in active power 1.0 and reactive power is 0.5

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Case 3:P=1.5 and Q=0.8

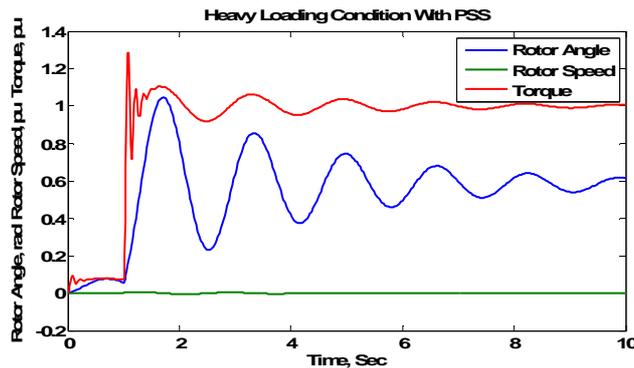


Fig.6 measurements for Light Loading Condition With PSS

Above fig.6 in the Normal loading condition with power system stabilizer. This case in active power 1.5 and reactive power is 0.8

With CPSS, the system becomes stable in all cases. The damping ratio and damping coefficient increases with increase in exciter gain.

When the value of K5 is negative, transients are more as loading increases and when the value of K5 is positive, higher rotor angle position is attained. Thus, CPSS design performance not proves effective in heavy loading condition.

To overcome these limitations, different intelligent techniques like ANN, FLC, GA, and PSO have been proposed.

VII. SIMULATION OF GAPSS

Case:1

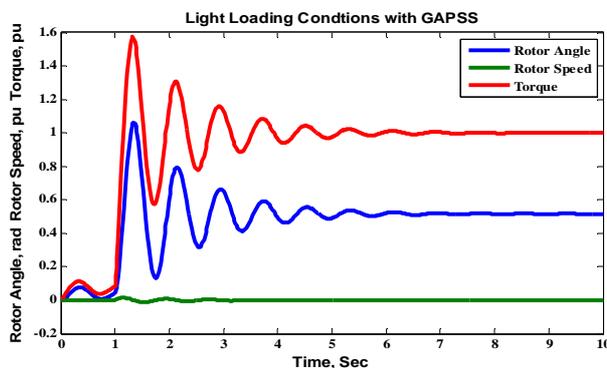


Fig 7.Measurements for Light Loading Condition With GAPSS

Above fig.4 in the light loading condition with power system stabilizer. This case in active power 0.5 and reactive power is 0.3

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Case:2

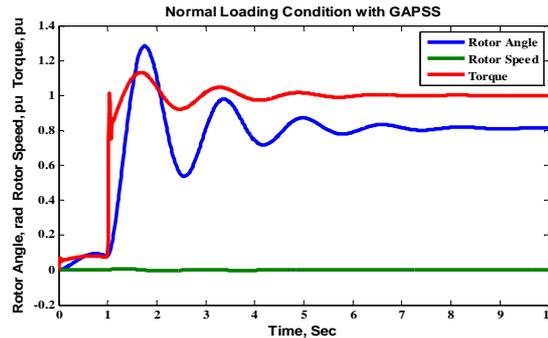


Fig 8.Measurements for Normal Loading Condition With GAPSS

Above fig.8 in the light loading condition with power system stabilizer. This case in active power 1.0 and reactive power is 0.5

Case :3

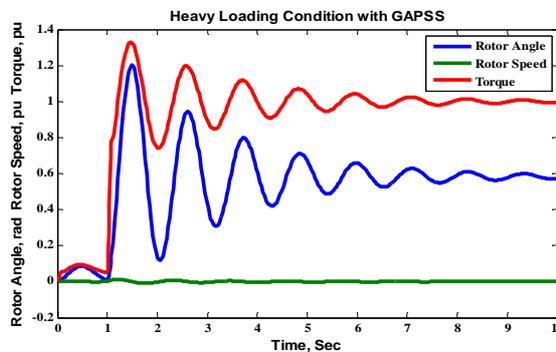


Fig.9 measurements for Heavy Loading Condition With GAPSS

Above fig.9 in the light loading condition with power system stabilizer. This case in active power 1.0 and reactive power is 0.8

VIII. CONCLUSION

In this paper single machine connected to the infinite bus in the power system. dynamic stability improvement for Genetic algorithm are used and PSS parameter tuning for genetic algorithm are used and compare the PSS and GAPSS. Rise time, settling time, peak time and overshoot time are very less in GAPSS than the CPSS.

APPENDIX

The Generator data:

$X_d=1.7$, $X_d'=0.245$, $X_q=1.64$, $X_q'=0.38$, $T''_{do}=5.9$, $D=0$, $H=2.37$, $F=50$

The Transmission line data:

$R_e=0.02$, $X_e=0.4$

AVR data:

$K_A=50$, $T_A=0.01$

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CPSS data:

$T_1=0.154$ sec, $T_2=0.033$ sec, $TW=1.4$ sec, $K_{stab}=9.5$

Heffron-philips constant= $K_1=1.0749$, $K_2=1.2576$, $K_3=0.3072$, $K_4=1.7124$, $K_5=-0.3988$, $K_6=0.4657$

NOMENCLATURE

K_1, K_2 = Constants derived from electrical torque
 K_3, K_4 = Constants derived from field voltage equation
 K_5, K_6 = Constants derived from terminal voltage magnitude
 K_A = Voltage regulator gain
 H = Inertia moment coefficient

X_d, X_q = Synchronous reactance in d and q axis
 D = Damping torque coefficient
 M = Inertia coefficient
 T_m, T_e = Mechanical and electrical torque
 E_{fd} = Excitation field voltage

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