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# A Review on PSO Based Load Frequency Control in Single& Two Area Connected System

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**Abstract:** This paper describes review on a function of load frequency control (LFC) in single and two interconnected power systems. It is based on PSO concept. The proposed algorithm is used to obtain the optimal values of the proportional-integral-derivation (PID) controller parameters based load frequency control. This paper presents a load frequency controller for elimination of the power system oscillations. A two-area power system based on PSO is considered; in which every area is equipped with PID controllers. The gain value of the integral controller is tuned using iterative PSO method. Each Area is considered without controller and with controller and then oscillations are removed by PSO method. Simulations will be done in MATLAB/Simulink.

**Keywords:** PSO, Load Frequency, Single Area, Multi Area System etc.

## I. INTRODUCTION

In actual power system operations, the load is changing continuously and randomly. As a result the real and reactive power demands on the power system are never steady, but continuously vary with the rising or falling trend. The real and reactive power generations must change accordingly to match the load perturbations. Load frequency control is essential for successful operation of power systems, especially interconnected power systems [12]. Without it the frequency of power supply may not be able to be controlled within the required limit band. To accomplish this, it becomes necessary to automatically regulate the operations of main steam valves or hydro gates in accordance with a suitable control strategy, which in turn controls the real power output of electric generators. The problem of controlling the output of electric generators in this way is termed as Automatic Generation Control (AGC)

Fig. 1.1 shows schematically the speed governing system of a steam turbine. The system consists of the following components:

(1) Fly ball speed governor: This is the heart of the system which senses the change in speed (frequency). As the speed increases the fly balls move outwards and the point B on linkage mechanism moves downwards. The reverse happens when the speed decreases.
(2) Hydraulic amplifier: It comprises a pilot valve and main piston arrangement. Low power level valve movement is converted into high power level piston valve movement. This is necessary in order to open or close the steam valve against high pressure steam.
(3) Linkage mechanism: ABC is a rigid link pivoted at B and CDE is another rigid link pivoted at D. This link mechanism provides a movement to the control valve in proportion to change in speed. It also provides a feedback from the steam valve movement.
(4) Speed changer: It provides a steady state power output setting for the turbine. Its downward movement opens the upper pilot valve so that more steam is admitted to the turbine under steady conditions (hence more steady power output). The reverse happens for upward movement of speed changer.

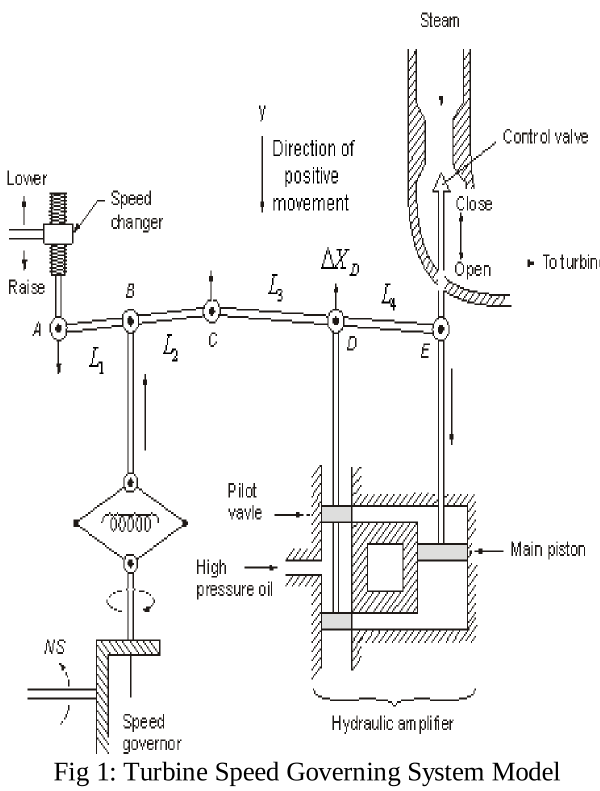

Fig 1: Turbine Speed Governing System Model

The dynamic response is largely influenced by two factors, (i) entrained steam between the inlet steam valve and first stage of the turbine, (ii) the storage action in the reheater

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which causes the output if the low pressure stage to lag behind that of the high pressure stage. Thus, the turbine transfer function is characterized by two time constants. For ease of analysis it will be assumed here that the turbine can be modelled to have a single equivalent time constant as given in Fig. 2.

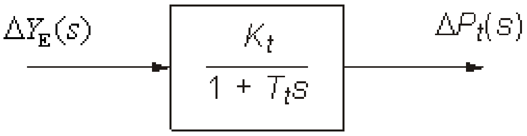


Fig. 2: Turbine transfer function model

Where, $K_t$= Gain of turbine, $T_t$= Time constant of turbine
The paper is ordered as follows. In section II, it represents related work with proposed system in Load Frequency Control System. In Section III, It defines proposed system. Finally, conclusion is explained in Section IV.

## II. RELATED WORK

Nour EL YakineKoubaet. al. [1] described an application of Artificial Bee Colony (ABC) to load frequency control (LFC) in single, two and multi-area interconnected power systems. The proposed ABC algorithm is used to obtain the optimal values of the proportional-integral-derivation (PID) controller parameters based load frequency control (LFC). The principal function of the LFC loop is to control the frequency and active power. The main aim of this work is to suppress all the fluctuations of the system due to the disturbance and get back the frequency at nominal value. In order to analyze the system frequency and the tie-line power flow with the varying of the load, the simulation is performed under load disturbances. Simulation results showed good performance in terms of settling time and peak overshoot of the proposed approach compared to the traditional ZieglerNichols, Genetics Algorithm (GA), Particle Swarm Optimization (PSO) and Bacterial Foraging Optimization (BFO) methods.

Miaomiao Maet. al. [2] integrated the wind turbines (WTs) into the interconnected power system and designsa distributed model predictive control (DMPC) controller for the primary frequency regulation problem. The WTs have been treated as a part of the power system to take part in primary frequency regulation with load disturbances. A frequency response model of multi-area power system including WTs is introduced, in which the physical constraints of the governors and turbines are considered. The distributed model predictive controller is designed by posing the primary frequency regulation problem as disturbance rejection problem of large system with state and input constraints. Analysis and simulation results for a two-area interconnected power system with WTs show possible improvements on closed-loop performance, while respecting physical hard constraints. Comparisons hadbeen made between the DMPC controller with and without WTs.

Hesam Parvanehet. al. [3] proposed an optimum load frequency control (LFC) of a multi-area power system is developed based on a powerful optimization technique called seeker optimization algorithm (SOA). SOA capabilities for solving difficult practical optimization problems had proven and therefore it has gained a massive consideration by researchers. This paper presents a SOA-based load frequency controller for elimination of the power system oscillations. A two-area power system based on thermal power plants (TPPs) is considered, in which every area is equipped with PID controllers. SOA is used for meeting the optimum parameters of the PID controller, which are acquired by time domain minimization of the objective function. Performance of the proposed controller is compared with genetic algorithm (GA) based PID controller and particle swarm optimization (PSO) based PID controller to indicate the excellence of the proposed algorithm for PID parameters regulation.

K. Jagatheesanet. al. [4] proposed the Automatic Generation Control (AGC) of multi-area hydrothermal interconnected power system with conventional controller. Multi-area power system consists of four power generating units (Two Hydro and two thermal). The thermal power generating is equipped with appropriate single stage re-heater unit and the hydro power generating unit is equipped with a suitable mechanical governor. All four areas are interconnected through tie-line. The conventional integral controller is employed into power system to improve the dynamic performance. The gain value of the integral controller is tuned using trial and error method with three different objective functions (Integral Time Square Error (ITSE), Integral Time Absolute Error (ITAE)) and one percent Step Load Perturbation (1%SLP) in area 1.

Dr. T. Anil Kumaret. al. [5] presented the coordinated control of HVDC link with optimal sliding mode control and HVDC link with H-infinity controller has been proposed to solve load frequency control of multi area power system in open market environment. The performance of proposed coordinated control strategies such as HVDC-OSMC, HVDC-H-infinity has been demonstrated on two area deregulated thermal power system under one possible contact scenario. The superiority of proposed new coordinated (HVDC-H-infinity) control strategy demonstrated over HVDC-OSMC (HVDC-Optimal sliding mode controller), HVDC-PI (HVDC-Conventional PI Controller) and without any controller.

Steven Rosenet. al. [6] integrated a 210 MW photovoltaic (PV) plant into a two-area four-machine power system. Due to the output variations of the PV plant, especially during cloudy conditions, the system frequency will significantly fluctuate. The objective of this paper is the optimal tuning of governors on synchronous generators in order to damp and mitigate frequency deviations as fast as possible. The governor parameters are tuned using a heuristic optimization method to provide the least number

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of frequency events and minimum frequency deviation with varying penetration levels of PV power. With optimally tuned governor parameters, a multi-area power system can operate reliably while maximizing the utilization of clean power generation sources.

Pouya Babahajianiet. al. [7] presented that Frequency control is one of the most important issues in a power system due to increasing size, changing structure and the complexity of interconnected power systems. Increasing economic constraints for power system quality and reliability and high operational costs of generation side controllers have inclined researchers to consider demand response as an alternative for preserving system frequency during off-normal conditions. However, the main obstacle is calculating the accurate amount of load related to the value of disturbances to be manipulated, specifically in a multi-area power system. Dealing with this challenge, this paper made an attempt to find a solution via monitoring the deviations of tie-line flows. The proposed solution calculates the magnitude of disturbances and simultaneously determines the area where disturbances occurred, to apply demand response exactly to the involved area. To address communication limitations, the impact of demand response delay on the frequency stability was investigated.

## III. LOAD FREQUENCY CONTROL SYSTEM

A complete block diagram representation of an isolated power system comprising turbine, generator, governor and load is easily obtained by combining the block diagrams with feedback loop as shown in Fig. 3 & Fig 4.

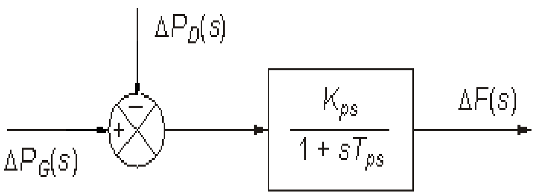


Fig. 3 Block diagram representation of generator-load model

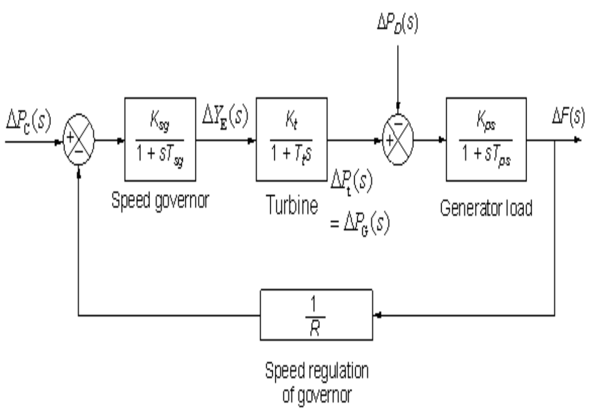


Fig. 4: Block Diagram Model of Load Frequency Control (isolated power system)

### 1. Steady States Analysis

The model of Fig. 4 shows that there are two important incremental inputs to the load frequency control system i.e. $-\Delta P_C$, the change in speed changer setting; and $\Delta P_D$, the change in load demand. Let us consider the speed changer has a fixed setting (i.e. $\Delta P_C = 0$) and load demand changes. This is known as free governor operation. For such an operation the steady change in system frequency for a sudden change in load demand by an amount $\Delta P_D$ (i.e $\Delta P_D(s) = \Delta P_D/s$) is obtained as follows:

$$\Delta F(s)|_{\Delta P_C(s)=0} = -\frac{K_{ps}}{(1+T_{ps}s)+\dfrac{K_{sg}K_tK_{ps}/R}{(1+T_{sg}s)(1+T_t s)}} \times \frac{\Delta P_D(s)}{s}$$

To obtain the dynamic response giving the change in frequency as function of the time for a step change in load, we must obtain the Laplace inverse of eq. The characteristic equation can be approximated as first order by examining the relative magnitudes of the time constants involved. Typical values of the time constants of load frequency control system are related as

$T_{sg} << T_t << T_{ps}$

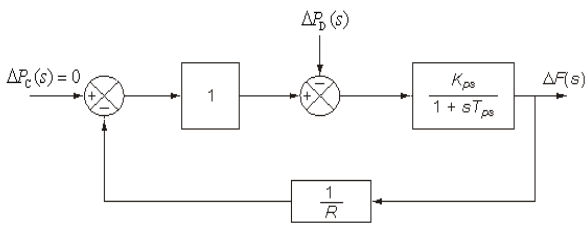


Fig. 5: First order approximate block diagram of load frequency control of an isolated area

## IV. PROBLEM DEFINITION

The problem of load frequency control has been one of the most accentuated topics in the operation of interconnected power systems. The LFC of an interconnected power system has two principal aspects such as maintenance of frequency and power exchange over tie-lines on scheduled values. The objective of LFC is to maintain the area generation-demand balance by adjusting the outputs on regulating units in response to deviations of frequency and tie-line exchange. In steady state, the output of the generators at any instant will exactly equal the load on the system and all the generating units operate synchronously at the same frequency. Immediately after a change in the total power demand, the flywheel governor of the synchronous machine try to return the system to the initial frequency but it is unable to do that. The main objective of this dissertation is to study the load frequency control problem associated in single and multi-area electrical power systems. In the present work some attention is given to single and two-area power system. At first uncontrolled system is studied and then improvement of its response is learnt on the application of integral controller and PSO.

## V. CONCLUSION

In this work, it reviews on Load frequency control system based on PSO and PID controller. In this dissertation LFC problem related to single-area, two-area and Three-area power systems is studied for uncontrolled case and then with the application of the integral controller, PSO based controller using MATLAB SIMULINK. The integral controller will be optimized using PSO based controller and will be shown that the PSO based integral controller provide better dynamic performance than integral controller in terms of lesser settling time and peak overshoots.

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