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Automatic Generation Control - A Review

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ABSTRACT

Automatic Generation Control is necessary for reliable & continuous operation of power system which is obtained by using different controllers. For efficient operation of the system, optimization of the different controlling parameters is necessary which can be obtained by using optimization techniques. Some of these techniques like genetic algorithm, BF, PSO etc. are discussed and a review is presented.

Keywords - Automatic Generation Control; Genetic Algorithm; Artificial Neural Network; Fuzzy logic; Bacterial Foraging; Particle Swarm Optimization

I. INTRODUCTION

Automatic Generation Control (AGC) problems are that of sudden small load perturbations which continuously disturb the normal operation of an electric energy system.[4] The analysis and design of Automatic Generation Control (AGC) system of individual generator eventually controlling large interconnections between different control areas plays a vital role in automation of power system. The purpose of AGC is to maintain system frequency very close to a specified nominal value to maintain generation of individual unit at the most economical value and to keep the correct value of the line power between different control areas [1]. A number of control strategies have been employed in the design of load frequency controllers in order to achieve better dynamic performance. Among the various types of load frequency controller .Conventional controller is simple for implementation but takes more time and gives large frequency deviation [8].

In view of the above discussion, the following are the main objectives of the present work:

- To maintain power balance in the system.
- Make sure that operating limits are not exceeded to Generators limit and Tie-lines limit.
- Make sure that system frequency is constant (not changed by load)[2][7][8].

In this paper, various techniques used for automatic generation control is presented. Conventional techniques employed for Automatic Generation Control was time-consuming. So an attempt for this controlling operation is obtained by intelligent techniques, which is briefly explained here.

II. DIFFERENT OPTIMIZATION TECHNIQUES

The first approach for Automatic generation control was by using synchronous machine. Here the control was obtained by the flywheel governor of synchronous machine. After that, various classical approaches were used based on transmission line bias control method. Thyristors and reactive compensators are also implemented for AGC control [1][2]. Further, the power system parameters do not remain constant due to various uncertainties in the system so a research related to AGC schemes having different uncertainties are considered [3][4]. Due to accurate and reliable operation of digital devices an interest is created towards the discrete mode based automatic generation control schemes [5][6]. A research related to it is represented by Hari. Increasing demand of renewable sources in power industry leads to use of renewable sources for AGC. An approach related to this is obtained by using energy storage devices like,

SMES, PV sources. In paper [7], SMES based system is used. It shows, SMES can yield dynamic stability and effectively suppress the frequency oscillations. The classical approaches used for AGC was time-consuming. So an idea of use of intelligent techniques for AGC is come into existence [8]. There are various intelligent techniques which are recently using for optimization of control parameters in the system. These all techniques can also be used in deregulated environment as the various changes are taking place in the structure of power system [9][10]. So a study of these in deregulated environment is necessary. The some of the intelligent techniques used for AGC are as:

- Genetic algorithm
- Artificial neural network
- Fuzzy based schemes
- Bacterial-foraging
- Particle Swarm Optimization

A. Genetic Algorithm

Genetic algorithm is a population-based technique. GA uses three operators for the population evolution i.e selection, crossover and mutation operators. It is used for discrete problems. It is a simple method but having limitation due to local minimum problem. It is used for optimization of parameters for short dimension problems. In paper [11], GA is applied on a two-area thermal system and results shows it provides reasonable fast response with no steady-state error. Sandeep Bhongade et.al[12] proposed a multi-area Automatic Generation Control (AGC) scheme suitable in a restructured interconnected power system with a proportional, integral and derivative (PID) controller to control the output of the generators. The parameter of PID controller has been tuned according to Genetic Algorithm (GA) based performance indices. Results are compared with conventional controller shows that GAPID controller is better than the conventional PID controller.

B. Artificial Neural Network

ANN networks are based on learning process. This is so popular due to its adaptive nature. It is mainly employed for non-linear problems [8]. In power system there is non-linearity or uncertainties. At that time a solution can be provided by using ANN. In paper [15], ANN is applied on a four-area system. Here an attempt was made to extend the optimal control design to a two are network. The assumption taken under consideration strictly followed that the system operation was normal throughout and the simulation were obtained without the presence of the integral controllers. An another approach is given by Sabahi,et.al[27] described a new adaptive controller based on unsupervised learning approach, named feedback error learning (FEL) for automatic generation control. Here in this strategy, both feed forward and feedback controller are used for control of process simultaneously. Dynamic neural network (DNN) is used as feed forward controller.

C. Fuzzy Based Schemes

Fuzzy logic is an efficient mathematical tool in handling many practical problems. The main advantage of fuzzy control theory is its ability to handle many practical problems that cannot be reliably handled by conventional control methods. Chown et.al [13] described a paper on design, of a fuzzy controller as part of the Automatic Generation Control system. This paper sets out the problems associated with secondary frequency control and AGC. The difficulties associated with optimising the original standard AGC controller, the design, implementation and optimisation of the fuzzy controller are discussed. Here, the fuzzy controller was integrated into the existing off-the- shelf AGC system with only a few modifications. In paper [14], Effects of variation of sampling time period on dynamic responses have been investigated, both with conventional integral controller and fuzzy logic controllers, considering small step perturbations. Effects of different number of triangular membership functions and inputs for Fuzzy Logic Controller on dynamic response have been explored. Further, dynamic responses under small step perturbation have been compared, considering integral and fuzzy logic controllers.

D. Bacterial-foraging

Bacterial Foraging (BF) algorithm is based on the social foraging behaviour of bacteria present in human intestine. It is an evolutionary algorithm which estimates cost function after each iterative step of the program as the program execution proceeds and leads to progressively better fitness i.e less cost function [16]. This algorithm has attracted a lot of attention as a high performance optimizer because of its faster convergence and global search approach. Sharma et.al[16] presented a paper on BF optimization and its applications. In paper [17], a comparison between BF & PSO is obtained. PSO & BF is applied for determining the optimization parameters of PID controller for speed control of brushless DC motor. Steady-state response is obtained to observe the output performance steady-state characteristics.

E. Particle Swarm Optimization

PSO is an optimization technique uses population-based approach. It is based on behaviour of bird-flocking. In this technique, particles fly in a multi-dimensional space following its best position. Russell et.al[18] represented a paper on PSO showing its development and use in various applications. Due to its fast convergence speed it is used in many applications. In paper [19], optimal design of power system Stabilizers is obtained by using a Small Population Based PSO. Here PSO is used to determine the optimal parameters of PSS. Pain et.al [20] presented a practical model for load frequency control (LFC) of two-area interconnected power system. A PID controller is used for the design and analysis of the proposed model and PSO is applied to obtain suitable control parameters to achieve the optimum performance. In paper [21], Particle Swarm Optimization with time-varying acceleration coefficients (TVAC-PSO) technique is used for the design of Integral (I) controller for the Load Frequency Control (LFC) system. The controller gains have been optimized using TVAC-PSO technique. The dynamic responses obtained shows that area frequency and tie line power deviations settle with zero steady state errors. In paper [22], tuning of the PID controller is done by using PSO. PID is used here to obtain load frequency control of three-area thermal system. An another approach is done by Kumar[23] to develop Fractional order PID controllers based on particle swarm optimization (PSO) for LFC control of two-area inter connected system. The dynamic response of the system has been obtained for 1% and 10% SLP and compared with ANFIS based intelligent controller. In [24] PSO approach is applied for the placement of different types of DGs to minimize the line losses.

F. Hybrid Techniques

To obtain the best system results, the intelligent techniques are combined to form a single hybrid technique by utilising the salient features of these techniques. Basis on this, Feng et.al [25] proposed a novel bacterial foraging swarm-based intelligent algorithm called the bacterial foraging particle swarm optimization (BFPSO) algorithm to design vector quantization (VQ)-based fuzzy-image compression systems. BFO behaviour is combined with a particle swarm optimization (PSO) learning scheme to obtain fast convergence and self-adaptive learning benefits. In paper [26], a hybrid Neuro Fuzzy controller is used for intelligent automatic generation control of two area interconnected power system. The system used is thermal and response shows better output behaviour of this controller. In paper [27], A hybrid neural network and fuzzy control is proposed for automatic generation control in power systems. Recurrent neural network is employed to forecast controller and system's future output, based on the current Area Control Error (ACE) and the predicted change-of-ACE. The Control Performance Standard (CPS) criterion is adapted to the fuzzy controller design, thus improves the dynamic quality of system. In [28], authors purposed the hybrid approach for the optimal placement of multiple DGs of multiple types in the distribution system to minimize the system losses.

III. CONCLUSION

In this paper, the various optimization techniques for the Automatic Generation Control are introduced. From above discussion, it is clear that all techniques are having its distinct benefits like GA is a simple technique, suitable for less dimension problems. BF has global search ability. ANN is based on adaptive learning with no need of programming. PSO has fast convergence speed. The use of each technique depends upon the type of requirement and application.

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