AUTOMATIC GENERATION CONTROL BY USING SWARM OPTIMIZED APPROACH

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Abstract

One of the most important issues in power system operation and protection is keeping the frequency and voltage in the nominal value or in predetermined limitation. The reliability and quality of generation power depend on balance between the power generated and power demand plus power losses in all over the power system. When this balance is disrupted causes deviation in frequency and tie-line power. Also, the loads are changed randomly. Hence using a proper control method it is necessary to prevent the power system to go to an unstable state. So far, different control method has been used to control the power system frequency in various type of power system.The FOPID controller is applied for stability analysis and compensation of reactive power in a micro-grid. The FOPID controller has two extra parameters more than PID controller that makes two degree of freedom in controller design and application. Hence, the FOPID controller has been applied to load frequency control of two area multi-source interconnected power system considering GRC and the Flexible Alternating Current Transmission System (FACTS) devices such as SMES, in this paper. Also, optimal tuning of controller parameters to achieve the good performance and dynamics response is necessary.

Keywords: FOPID, PID, micro-grid, SMES, GRC, Flexible Alternating Current Transmission System (FACTS**)**

1. INTRODUCTION

Automatic generation Control (AGC) is one of the essential control strategy in interconnected power system to ensure reliable and secure operation. Any mismatch between power generation and power consumed may results into frequency deviation which is undesirable from stability point of view. The primary goals of AGC is to control the system frequency and scheduled tie-power flow between interconnected control areas to their desired tolerance values under normal as well as abnormal conditions. To achieve these objectives, numbers of control strategies has been reported over a past decade. Several advanced control methods viz. optimal control technique, variable structure control; self-tuning and adaptive control were reported to deals with the AGC problems. However, all the aforesaid methods either require details on the system states or an online identifier which may be very difficult to be realized in practical case.

2. AUTOMATIC GENERATION CONTROL (AGC)

Even though many control strategies have been established, most of the power industries still use conventional IO based PI controller and their tuning is performed based on trial and error method. However, it is seen that the basic approaches of IO classical controller are not much effective in achieving good dynamic performances when system loading and other parameters changes. Also there is no surety that such IO based conventional controller would provide improved performance under realistically conditions like GRC and governor dead-band (GDB).To overcome these problems, fractional order (FO) based controller for multi-area system under deregulated scenario is introduced. The investigations concluded that FOPID controller outperforms the conventional controllers. Subsequently, it further explored the performance of fractional order controller for 3-area power system. The superiority of fractional order controller is because of its two extra tuning knobs known as fractional order of integrator and fractional order of differentiator that provides more flexibility for adjustment of system dynamics. During the last few decades application of fractional Order (FO) controller has gained more popularity in the areas of power system control.Further, 2-DOF-PID based controller for tracking load frequency control (LFC) has been designed. Advantage of 2-DOF over single degree of freedom (1-DOF) control structure is to achieve good performance in set-point tracking as well as better controlling when disturbance signals is present.. An interconnected power system in practical scenario may consist of combination of thermal and hydro system or diverse sources such as hydro, thermal and gas units. Performance of fractional order controller on multi source system is not yet tested by any of the authors. The major problem concerned with classical controller is the optimum selection of the parameters that minimizes the deviations and guarantees zero steady state error. Over a past decade, numerous heuristic approaches have been published in the literature for AGC problem. These approaches includes differential evolution (DE), firefly algorithm (FA), genetic algorithm (GA), particle swarm optimization (PSO), artificial bee colony (ABC), bacterial foraging optimization (BFO), etc. FA is highly robust than ABC, BFO and PSO and produce more optimal solution.However, aforesaid optimization techniques have several controllable parameters that need to be chosen properly for better performance. Very recently, cuckoo search algorithm (CSA), a new nature inspired optimization algorithm, has been used successfully for several complex engineering problems. CSA is an optimization technique developed by X.S Yang which is inspired from the obligate brood parasitism of some cuckoo species by laying their eggs in the nests of other birds. The main advantage associated with CSA over other search algorithms is that it has only two controllable parameters i.e. the size of population (n) and discovering probability (Pa). Few parameters of CSA make it very simple and potentially more generic over other established algorithms. It is also found that rate of convergence of CSA is insensitive to discovering probability. Subsequently, CSA has lesser tendency to be trapped in local minima than GA and PSO.

3. FOPID Controller

The PID controller is one of the most applicable controllers that is used in industrial applications [11]. In the [12] an improved form of PID controller is proposed by converting the integer order of derivative and integrator into the fractional order. This controller is known as FOPID (PIλDμ) controller. Hence, the only difference between the PID and FOPID controller is the order of calculus operators that make more degree of freedom and flexibility in design and practice. The mathematical formulation of FOPID controller is as follows:

$$C(s) = K_p + K_i \frac{1}{S^{\gamma}} + K_D S^{\mu}$$

λ and μ are fractional order of integrator and derivative, respectively. The structure of FOPID controller is given in Fig. 1.

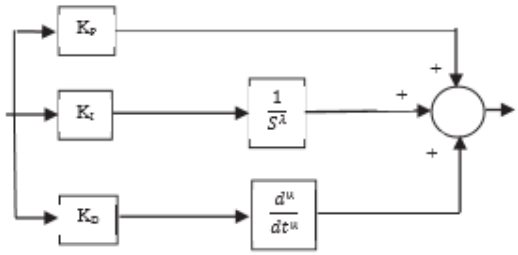

Fig. 1. FOPID controller structure

4. FRACTIONAL ORDER 2-DOF CONTROLLER

Concept of 2-DOF controller recently received an increasing interest recently in the control engineering community due to its quality control in terms of set point tracking and disturbance rejection. It is observed that introduction of fractional order (FO) calculus idea to integer-order (IO) controller design increases the flexibility. The most commonly used Riemann-Liouville (R-L) definition for fractional derivative is

$${}_aD_t^{\alpha} f(t) = \frac{1}{\Gamma(n-\alpha)} \frac{d^n}{dt^n} \int_a^t (t-\tau)^{n-\alpha-1} f(\tau) d\tau$$

where n–1 Į < n, n is an integer and Ł (.) is the Euler's gamma function. And the definition for fractional integral is given by equation

$${}_aD_t^{-\alpha} f(t) = \frac{1}{\Gamma(\alpha)} \int_a^t (t-\tau)^{\alpha-1} f(\tau) d\tau$$

Where, ${}_aD_t^{-\alpha}$ is the fractional operator

5. CONCLUSIONS

In this case study traditional systems for FOPID based power grid systems many researches had been conducted in order to reduce the overshoot in the output. Most of research was done by applying the cuckoo search optimization algorithm in order to obtain reduced overshoot in PID based power systems. By applying the cuckoo search the overshoot was reduced but not to a satisfactory level asitis considered as the oldest method used for optimization. It suffers from lot of problems such as in cuckoo search algorithm a cuckoo can laid down only one egg in the nest then each egg in the nest considered as a candidate for the solution. Similarly each nest can have multiple eggs and hence it can leads to the multiple candidates for the solution. The aim of the cuckoo search algorithm is to generate a more appropriate solution as compare to the worse solution in order to replace the inappropriate solution with it.

Hence, it requires enhancing the values but in some real time based applications, there is a requirement of minimum value which cannot be obtained by using the cuckoo search algorithm.

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