Smart Supervisor Controller design for Load Frequency Control of Multi-area Interconnected Power System

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***Abstract* - This paper proposes a new smart supervisor controller (SSC) for load frequency control (LFC). The smart supervisor controller makes a smart selection between two different controllers to combine the advantages of each one. There are some controllers are simple for implementation such as proportional-integral (PI) controller but may have some drawback when the complexity in the system increases. This drawback may be due to the design method of gain selection of the PI controller. The design method may make the PI controller reduces the maximum overshoot of the system response but the settling time increases. In contrary, another different design method may make the PI controller reduces the settling time of the system response but the maximum overshoot increases. The proposed SSC makes a smart selection between the different PI controllers based on the advantage of each design method which can add it to the system. A two-area interconnected power system is considered to realize this study. Simulation results confirm on the better performance of the proposed SSC compared to the genetic algorithm (GA)-based PI controller and bacterial foraging optimization algorithm (BFOA)-based PI controller over a wide range of load changes and system parameters uncertainties.**

Index Terms *- Load frequency control (LFC), smart supervisor controller (SSC), proportional-integral (PI) controller*

I. INTRODUCTION

In the modern age, the demand for the most reliable power supply increased [1]. The continuous change of power demand makes the grid frequency deviated from the permissible limit [2]. The using of conventional controllers had become not feasible to overcome the load frequency control (LFC) problem [3]. The conventional proportional-integral (PI) controllers are the widest controllers among various types of load frequency controllers [4]. These controllers are very simple in the implementation and give a better dynamic response, but they have a bad performance as the system complexity increases [5, 6]. Furthermore, the PI controller may not provide optimal control in many situations and causes the problem of system instability due to the improper selection of controller parameters [5]. When using these controllers, the main target is the optimal selection of parameters, which is named the optimization. There are different types of artificial intelligence (AI) techniques for the optimal tuning of these parameters such as genetic algorithm (GA) [7-10], particle swarm optimization (PSO) [11, 12], bacterial foraging optimization algorithm (BFOA) [13, 14], artificial bee colony (ABC) [15-17], fuzzy logic (FL) [18, 19], artificial neural networks (ANN) [20], imperialist competitive algorithm (ICA) [21], gravitation search algorithm (GSA) [22, 23], bat inspired algorithm (BIA) [24, 25], and other techniques [26-30]. Some of these different design methods may make the PI controller reduces the maximum overshoot of the system response but the settling time increases. In contrary, the rest of these different design methods may make the PI controller reduces the settling time of the system response but the maximum overshoot increases [31]. This paper proposes a new smart supervisor controller (SSC) to overcome the drawbacks of these different design methods for load frequency control (LFC) in a two-area interconnected power system. The proposed SSC is applied to make a smart selection between GA-based PI controllers and BFOA-based PI controller to combine the advantages of each one. The performance of the proposed SSC is evaluated by comparison with GA-based PI controllers and BFOA-based PI controller.

The rest of the paper is classified as follow. The smart supervisor controller is described in Section 2. Section 3 gives an overview of the candidate SSC design for a two-area interconnected power system. In Section 4, the simulation results are presented. Finally, the conclusions are provided in Section 5. At the end, the appendix and the cited references are listed.

II. SMART SUPERVISOR CONTROLLER

The smart supervisor controller selects between two different controllers. The selection of each controller depends on the benefit, which can add it to the system. For example, Fig. 1 shows the frequency deviation ΔF_i of a power system by two different controllers due to [31]. It is clear that from this figure, the frequency deviation of the system by controller$_2$ has less settling time compared with controller$_1$ but the frequency deviation of the system by controller$_1$ has less maximum overshoot compared with controller$_2$. The smart supervisor controller makes switching between controller$_1$ and controller$_2$ to combine the benefit of controller$_2$, which is the minimum settling time and the benefit of controller$_1$, which is the minimum overshoot. The switching criteria depend on the