Ain Shams University
Faculty of Engineering
Electrical power and Machines Department

Load Frequency Control for Interconnected Power System

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B.Sc. Electrical Engineering, Ain Shams University

A Thesis Submitted in Partial Fulfillment of the Requirement for the Degree of Master of Science in Electrical Engineering

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STATEMENT

This thesis is submitted as partial fulfillment of M.Sc. degree in Electrical Engineering, Faculty of Engineering, Ain Shams University.

The author carried out the work included in this thesis, and no part of it has been submitted for a degree or qualification at any other scientific entity.

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Mohamed Mostafa Elsaied Mohamed

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List of Abbreviations

HS	Harmony Search Algorithm
TLBO	Teaching-Learning-Based Optimization
SCA	Sine Cosine Algorithm
I	Integral
PI	Proportional-Integral
PID	Proportional Integral Derivative
PIDA	Proportional Integral Derivative Accelerator
LFC	Load Frequency Control
AGC	Automatic Generation Control
GA	Genetic Algorithm
HPSO	Hybrid Particle Swarm Optimization
ANN	Artificial Neural Network
ICA	Imperialist Competitive Algorithm
BFOA	Bacteria Foraging Optimization Algorithm
AWPSO	Adaptive Weighted Particle Swarm Optimization
DE	Differential Evolution
FA	Fire Fly
ACE	Area Control Error
WECS	Wave Energy Conversion System
AWS	Archimedes Wave Swing

Thesis Summary

Nowadays a large power system usually comprises of small interconnected power systems each one is called an area so large power system is called a multi area system. Each area is connected to the other one by a tie line. During load change in one area, the frequency and the tie line power of the whole system deviate from the nominal values. The purpose in this thesis is to get the best performance of the system through less deviations.

Three optimization techniques Harmony Search (HS), Teaching Learning Based Optimization (TLBO), and Sine Cosine Algorithm (SCA) were applied on two controllers (PID and PIDA) to optimize the system performance and eliminate the steady state error in the system deviations. Four case studies were done on the system and simulated to observe the best controller and the best algorithm. The system under study is a two area system each area equipped with its own controller.

The first case study is simulated by making 1% increase in the load in area "1" and obtain the optimized parameters of the two controllers and the corresponding response of the system frequency and the tie line power deviations. The second case study is done by making 1% load increase in area "2" while the third case study is simulated by making 1% load increase in area "1" & "2" at the same time.

After obtaining all system's results comparison is done between the three optimization techniques and the two controllers. The results proved that TLBO technique and PIDA controller give the best system performance among the mentioned techniques and controllers. In the fourth case study; Wave Energy Conversion System (WECS) is applied also on the system when equipped with the

PIDA and TLBO and then compared with the uncontrolled case. The system in the controlled case has better response than in the uncontrolled case.

Keywords:
Multi Area System, Load Frequency Control (LFC), Interconnected Power System, Automatic Generation Control (AGC).

CHAPTER ONE
INTRODUCTION

1.1 General

The power system active power mainly dependent on the system frequency while the reactive power is less dependent on it and mainly dependent on the system voltage. So, the active and reactive powers are independent on each other and can be controlled separately. The active power is controlled using the load frequency control loop (LFC) while the reactive power is controlled using the Automatic Voltage Regulator (AVR). Load Frequency Control has gained a great importance with the growth of interconnected power systems so made it much easier to control the system frequency in interconnected power systems [1].

The Automatic Generation Control (AGC) usually comprises of load frequency control, economic dispatch, and interchange scheduling. The speed governors of all machines sense the mechanical outputs and the frequency will be changed automatically to match with the combined generation of new combined load. This action is called primary frequency regulation.

Subsystems are usually connected together to establish a large scale power system which is called a multi-area system as shown in Fig.1.1. Due to load change in one area, the generators of this area and the generators in other areas are responsible for compensating this change in order to maintain the system frequency at permissible limits to provide acceptable high level of power quality. Due to the load increase in one area, the generators of other areas provide active power in tie lines to help with the generators in this area. The tie line power is preferred to vanish at steady state in order to decrease the system losses.