ISSN (Online) 2321 – 2004
ISSN (Print) 2321 – 5526

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH IN ELECTRICAL, ELECTRONICS, INSTRUMENTATION AND CONTROL ENGINEERING
Vol. 2, Issue 6, June 2014

PID Controller Using FLC

Ajay Kumar Pandey[1], Aziz Ahmad[2] and J.K. Garg[3]

Department of Electrical & Electronics Engineering, Alfalah School of Engineering & Technology Faridabad, India[1,2,3]

Abstract: An important problem is the Automatic Load Frequency Control (ALFC) which is directly related to interconnection in power systems. Other problems related to such interconnection like the Automatic Voltage Regulation (AVR) have less interaction in operation with ALFC. As the demand of electrical power is increasing and becoming a global issue, the need of interconnecting power systems is growing up; this growth represents a great challenge for power engineers, in making power systems reliable, economic and safe for both supplier and customers.

Keywords: Power System; Automatic Load Frequency Control; Automatic Voltage Regulation; Fuzzy Logic Controller (FLC).

I. INTRODUCTION

Now day's power systems are distributed into various areas. For illustration in India, there are five regional grids, e.g., Eastern Region, Western Region etc. Each of these areas is generally interconnected to its neighbouring areas. The transmission lines that connect an area to its neighbouring area are called tie-lines. Power sharing between two areas occurs through these tie-lines. Automatic Load frequency control (ALFC) regulates the power flow between different areas while holding the frequency constant[1]. For large scale electric power systems with interconnected areas, Automatic Load Frequency Control (ALFC) is important to keep the system frequency and the inter-area tie power as near to the scheduled values as possible. The input mechanical power to the generators is used to control the frequency of output electrical power and to maintain the power exchange between the areas as scheduled. A well designed and operated electric power system must cope with changes in the load and with system disturbances, and it should provide acceptable high level of power quality while maintaining [2] both voltage and frequency within tolerable limits. Many control strategies for Load Frequency Control in electric power systems have been proposed by researchers over the past decades.

II. ALFC AND AVR OF A SYNCHRONOUS GENERATOR

Since synchronous generators are the most common type of machines used in the generation of electrical power, its characteristics can be used to describe the relationship between frequency and power during load changes [2]. All generators are driven by a prime mover, which is the generators source of mechanical power. The most common type of prime mover is a steam turbine, but other types include diesel engines, gas turbines, water turbines, and even wind turbines. Regardless of the original power source, all prime movers tend to behave in a similar fashion as the power drawn from them increases, the speed at which they turn decreases. The decrease in speed is in general non-linear, but some form of governor mechanism [3] is usually included to make the decrease in speed linear with an increase in power demand. Whatever mechanism is presented on a prime mover, it will always be adjusted to provide a slight drooping characteristic with increasing load.

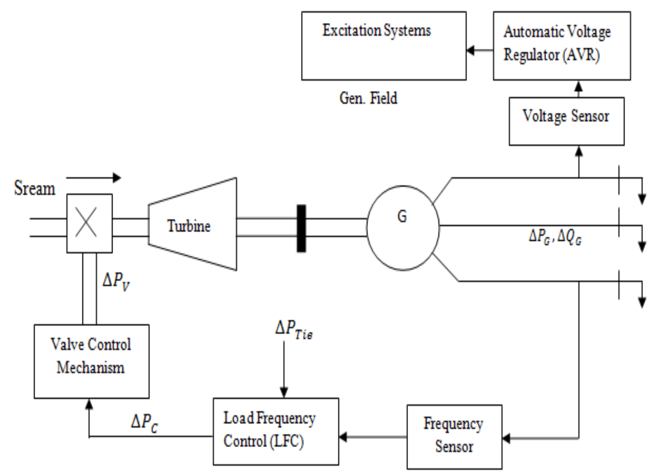

Fig.1 ALFC and AVR of a synchronous generator

The controllers are set to take care of any changes in load demand to maintain the frequency and voltage within specified limits. Small changes in real power refer to change in the angle δ (rotor angle) and this will affect the frequency. Since reactive power depends on |V| thus the excitation of the generator is a factor affects reactive power
The operational objectives of ALFC are

- Maintain reasonably uniform frequency
- Control tie-line interchange schedules
- Divide the load between the generators

Changes in frequency and real power are sensed, and these are a measure of changes in rotor angle (δ); so the error Δδ is to be corrected. Error signals such as Δf and ΔP are amplified, then mixed, then transformed into a real power signal, which is sent to turbine to cause an increment in torque [4]. Therefore, the prime mover (steam turbine) cause changes in the generator output by certain amount to

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change the value of Δf and ΔP within a specified tolerance, this mechanism is discussed in details when we consider the modeling of governor and prime mover. By using proportional controller simulate single area ALFC as shown in Fig 2.

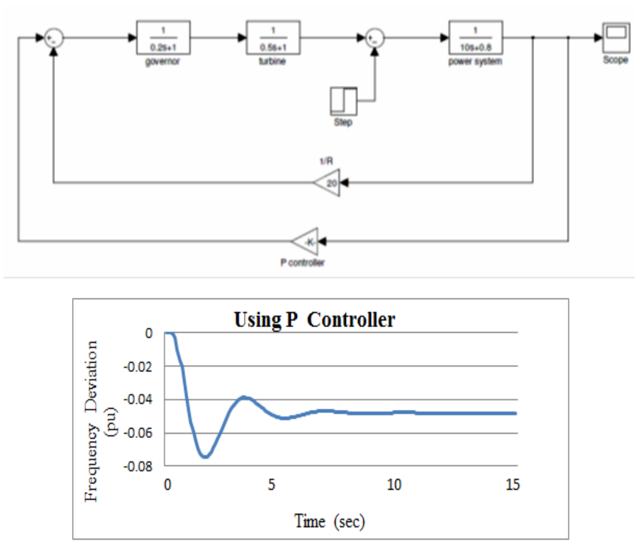

Fig 2: Model and simulation results of single area isolated system

Fig.2 indicates that change in frequency deviation is negative which implies that the frequency drops in the area following a step load changes

In order to reduce the frequency deviation to zero, we must provide a reset action; the reset action can be achieved by adding integral controller [5]. The LFC system with addition of integral controller is shown in Fig 3.

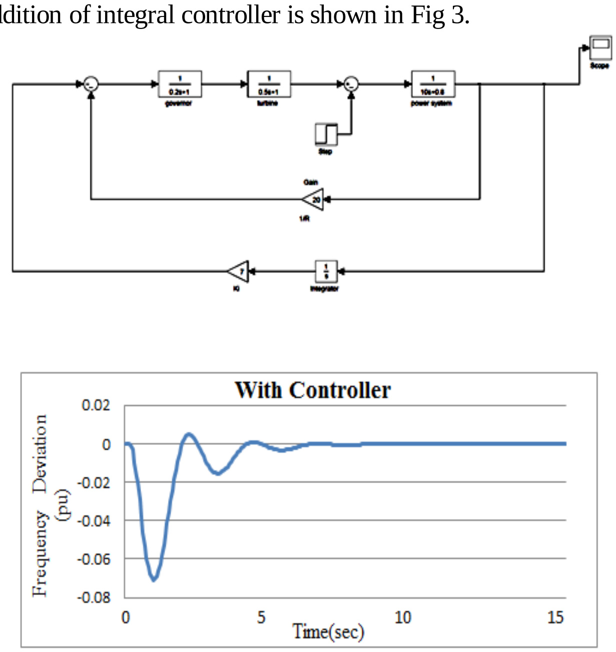

Fig 3: Model and Simulation results of isolated power system with AGC loop

Fig.3 indicates that the frequency deviation becomes zero. That means frequency deviation reaches to steady state condition [6].

By using Proportional-Integral-Derivative (PID) Controller simulate single area ALFC as shown in Fig 4.

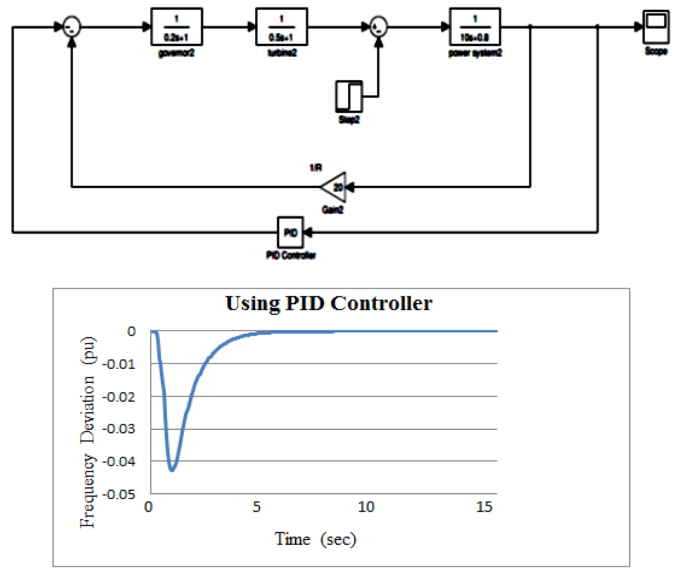

Fig 4: Model and simulation results of PID controller

Fig 4 indicates that the frequency deviation is zero, and it gives less oscillation and less settling time. PID controller gives better response compared to PI controller [7]-[8].

III. FUZZY LOGIC CONTROLLER

Fuzzy logic controllers (FLC) based on fuzzy set theory are used to represent the experience and knowledge of a human operator in terms of linguistic variables that are called fuzzy rules. Since an experienced human operator adjusts the system inputs to get a desired output by just looking at the system output without any knowledge on the system's dynamics and interior parameter variations, the implementation of linguistic fuzzy rules based on the procedures done by human operators does not also require a mathematical model of the system. Therefore a fuzzy logic controller becomes nonlinear and adaptive in nature having a robust performance under parameter variations with the ability to get desired control actions for complex, uncertain, and nonlinear systems without the requirement of their mathematical models and parameter estimation. FL based controllers provide a mathematical foundation for approximate reasoning, which has been proven to be very successful in a variety of applications. In modern control techniques, uncertainty and vagueness have a great amount of importance to be dealt with. The use of membership functions quantified from ambiguous terms in fuzzy logic control rules has given a pulse to speed up the control of the systems with uncertainty and vagueness.

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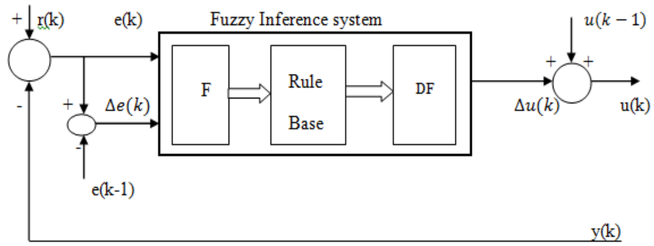

Fig 5: The basic structure of fuzzy logic based controller

IV. MODELING AND SIMULATION OF FLC MATLAB/SIMULINK ENVIRONMENT

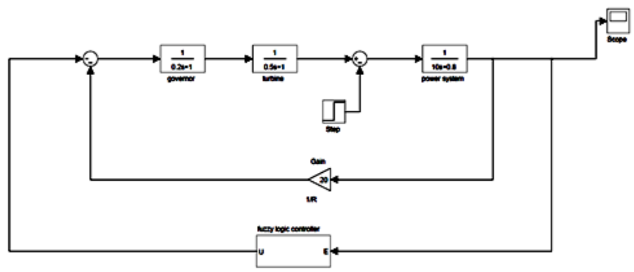

Fig 6: simulation model of single area ALFC using FLC

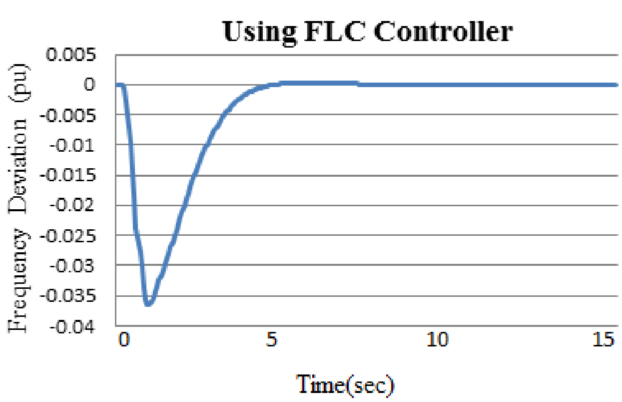

Fig 7: simulation results of single area ALFC using FLC

V. RESULTS COMPARISON OF SINGLE AREA ALFC

Fig 8 indicate fuzzy logic controller gives less oscillation and less settling time compared to other controllers. Fuzzy logic controller give better response compared to other controllers.

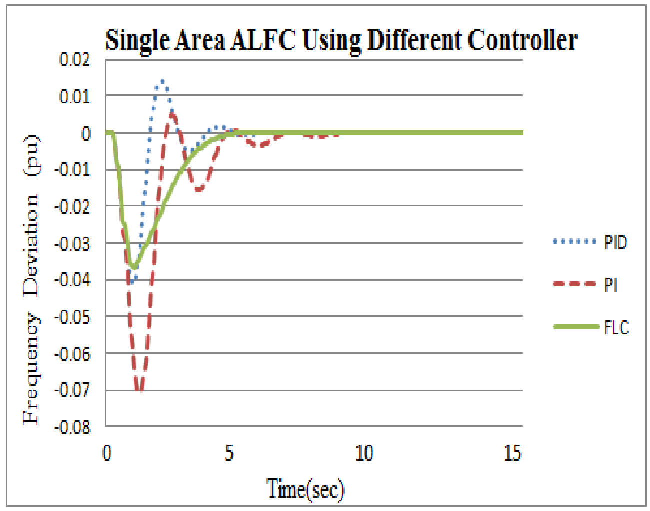

Fig 8: Results comparison of single area ALFC

VI. CONCLUSION

In this paper the modelling and designing of single automatic load frequency control and fuzzy logic control have been given. And also simulation results have been given. Fuzzy logic controller gives better response compared to conventional (PI, PID) controllers

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