LFC AND AVR BASED MULTI AREA POWER SYSTEM USING INTELLIGENT TECHNIQUES

A.Surendhar, M.E. Student in Dept. of Electrical and Electronics Engineering from Sona college of Technology

Abstract- **In this paper we are going to discuss about the effects of these LFC and AVR are studied by extending AGC, PWM Controller Voltage Regulator which uses on the distribution power system, controls power factor and able to regulate the steady voltage and current. In overall model we have to study the oscillation of frequency and voltage regulation with the help of PWM and ANFIS controllers. This model is tested in a multi area power system.**

Keywords – **Load Frequency Control, Automatic Voltage Regulation, Automatic Generation Control, PWM, ANFIS controllers, Excitation system.**

I.INTRODUCTION

In recent times the usage of the computers has increased over the power system in balancing quality and reliability of the power supply and also it make system more efficient and user friendly. Likewise the size and complexity of power systems along with increasing power demand. In modern technology the artificial intelligent are used which possess high knowledge and adapt themselves in the situations. The automatic control system plays major role in the system to detects these changes and initiate in real time application which will eliminate as effectively and quickly as possible. The active and reactive power demands are change continuously with rising and falling. Here in power system, Load Frequency Control (LFC) and Automatic Voltage Regulator (AVR) plays major role in the system to allow power exchange and regulate voltage. LFC in a power which help to increase the system performance and bring constant and stable frequency or voltages. LFC in power system is very important in order to supply reliable electric power system with good quality and reduce the steady state error to zero in power system. During the operation both the frequency and voltage to remain at standard values to give good quality of the power system. It will be impossible to maintain both the active and reactive power without any control which results in imbalance, the frequency and voltage levels which leads to changes in the loads of the system. Therefore, it is essential to cancel the effect of the loads changes and keep the frequency and voltage, at standard values. During the last decades there are many researches have done in LFC and AVR although the main goal of the power system is, to generate both frequency and voltage within standard limits. In recenttimes lot of researches and works were documented to give proper coupling effects between LFC and AVR.

NEED TO MAINTAIN FREQUENCY AND VOLTAGE CONSTANT

1. REASONS TO KEEP THE FREQUNCY AT CONSTANT LEVEL
    - Frequency must be maintain constant in order to maintain speed in the most of the AC motors in the power system.
    - Frequency needs to be maintain nearly 50 Hz because in the stream turbine may not able to withstand frequency deviation of +2 and -2.5 Hz for more than an hour in its entire lifetime of the turbine.
    - Changes in frequency which leads to damage in the circuit and also affects the continuous operation in industries.
    - Basically the loads and the other equipment are designed to operate at a particular frequency. The change in the operated frequency which leads to damage in circuit and may reduce power plant output.
    - In India, at the present grid frequency deviation in grids is generally in between 50.5 to 49.0 Hz under normal operation condition.

2. REASONS TO KEEP THE VOLTAGEAT CONTANT LEVEL
    - Variations of loads in the induction motor leads to affect the motor and change the torque.
    - In lighting loads like fluorescent and incandescent lamp are more sensitive to the changes in the voltage which causes damage to the lamp.
    - Like the fluorescent lamp, fluorescent tube will not glow in television set will starts rolling due to the voltage are below a specific level.
    - If the voltage variation is very large than a given vale then the performance of the system will affected and the life of the equipment may reduce.
    - Generally in motors torque is directly proportional to the square of the terminal voltage.

II. LOADFREQUENCY CONTROL

Load Frequency Control (LFC) is basically used to maintain the system frequency and the inter-area power as near to the specified values as possible. By maintaining the input power of

the generators used to control the frequency of the output power and also maintain the power exchange between the as scheduled. A power system said to be well designed and operated with changes in the load and disturbances, and it should be provide high level power quality is only possible when both the frequency and voltage within tolerable limits. Load frequency control is basic control mechanism in the power system operation. Whenever there is variation in load demand on the unit, there is an occurrence of unbalance between power input and output of the system. This difference is due to changes in the frequency. Here Load Frequency Control (LFC) play a major role in Automatic Generation Control (AGC) for several years in the power system.

Basically AGC is used to maintain the frequency of the system at nominal value (50 Hz).

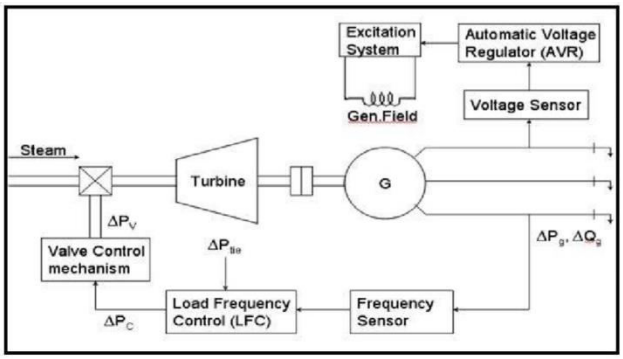

Figure 1.Automatic Generation Control with LFC.

LFC is also used for the regulation of the system frequency. It is also called as power factor control loop and influence the active power system network. The main principle for the mechanism of the speed governor is to adjust itself as per the variations of the load and the speed of the rotor. Hence the change in the speed and load which results in change in frequency. This change in frequency is sensed by the frequency sensor by comparing reference frequency and feedback signal

We know that

Speed (N) = 120 f / P

Therefore N α f,

Where f = frequency in Hz,

P = No of poles

From the above equation speed is indirectly proportional to frequency which means change in speed which leads to change in frequency.

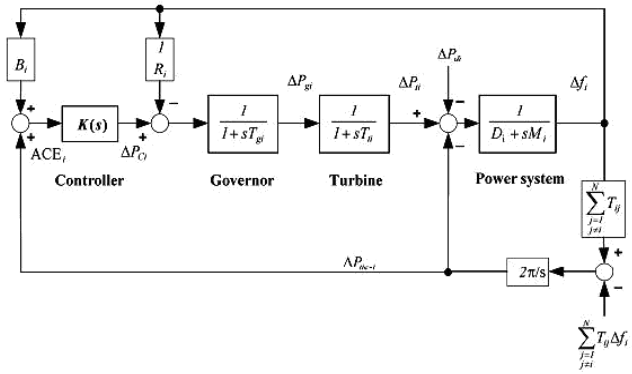

Fig 2.Schematic diagram of control area equipped with LFC.

In stream turbine the variation of generated power by adjusting the opening of the stream inlet valve to turbine. By this above adjustment in turbine power balance and load demand is achieved.

In the schematic diagram of LFC consists of two loops. They are Primary and Secondary control loops.

1. *Primary control loop* is otherwise known as speedgovernor control loop. It consists of generator, speed governor and turbine.
2. *Secondary control loop* is combines the Primary loop with ANFIS.

CONCEPT OF TWO AREA CONTROL

An extended power system can be divided into number of LFC areas interconnected or AVR by means if tie lines. Generally loss is reduced in two area connection by using tie line.

The control area objectives are:

- Each area is supplied its own load demand and power transfer through tie line connection.
- It should controllable by frequency controller.

The two single areas network is connected through a power line called tie line. Tie line allows electric power to flow between each areas. Information about the area is found in the tie line power fluctuations. Therefore, tie line area first sensed and then fed back into both areas in the system. It is assumed that each area is represented by an equivalent turbine, generator and governor system. A complete diagram is shown in Fig.3

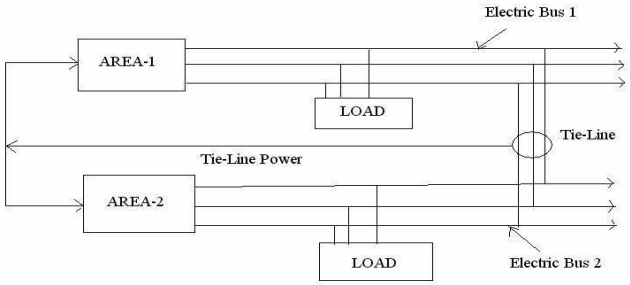

Fig 3. Conventional two area control.

III. AUTOMATIC VOLTAGE REGULATOR

Automatic Voltage Regulation (AVR) is nothing but of regulation of system voltage by influence the reactive power balances in the power system network. This technique is otherwise known as reactive power control loop. By using this method we can maintain the generated voltage in standard limits.

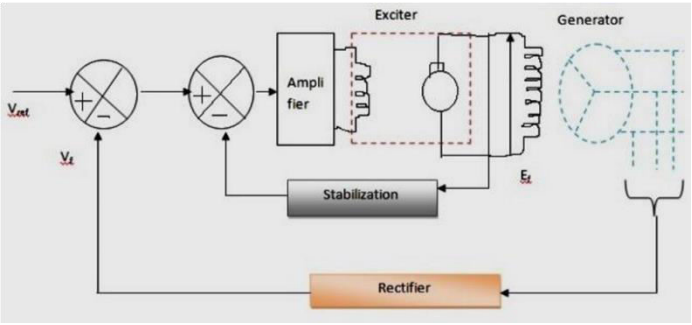

Fig 4. Schematic diagram of AVR.

In the above we are discussed about frequency that the frequency is various by changing the speed of the generator likewise, the voltage of the generator is proportional to the speed and excitation of the generator. If we maintain the voltage at the constant level, then the speed of the generator is controlled, so the voltage of the system should maintained constant. This type voltage control is known as excitation control system.

A voltage regulator is a voltage stabilizer that is designed to automatically stabilize voltage at constant level. A voltage circuit is also used to change or stabilize the voltage level According to the requirement of the circuit.

Thus, a voltage regulator is used for main two reasons are:

1. To regulate or vary the output voltage of the circuit system.
2. To keep the output voltage constant at the desired value in spite of variations in the supply voltage or in the load current.
3.

The generator terminal voltage V_t is compared with reference voltage V_{ref} to obtain an error signal as ΔV. This signal is applied to the exciter as a voltage function as $K_A/(1+ST_A)$. The regulator output is shown on Fig.5.with transfer function $Kg/(1+STo)$.

The generator field can represent by a transfer function $K_e/(1+ST_f)$.The total transfer is given as

$$\frac{\Delta V}{\Delta V_{ref}} = \frac{G(s)}{1+G(s)} \quad \text{where,} \quad G(s) = \frac{K_A K_e K_F}{(1+sT_A)(1+sT_e)(1+sT_F)}$$

AVR MODELLING

Basically the role of the AVR is the hold the voltage of the generator at a specific limits. A simple AVR system consists of four main components and they are namely amplifier, exciter, generator and sensor. The basic diagram is shown in Fig.4.

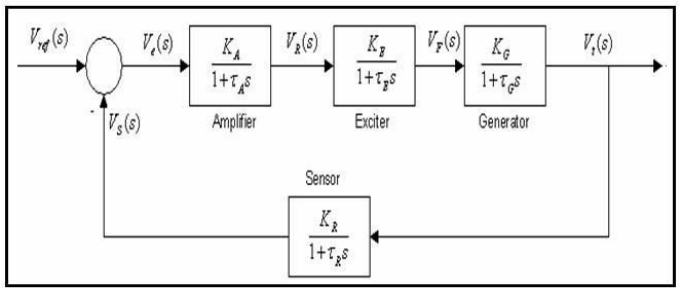

Fig.5. Basic diagram of AVR

The reasonable transfer function of these components may be represented respectively, the generator voltage and reactive power control is done by using an automatic voltage regulator (AVR).

In the comparator the error voltage is rise from the output of the comparator amplified in the amplifier and applied voltage to the controllers. So, the output of the controller is control by the change voltage of the generators.

CONTROL AND ESTIMATION TOOLS MANAGER

Generally a toolbox of the control system is consists of standard algorithm and tools for analyzing, designing, and tuning control systems. We can also define some specifications based on our own usage of the system factors like transfer function, state, frequency response and voltage deviation are specified. By using this tools we can also tune compensator parameters using PID, ANFIS controller tuning, internal model tuning, loop shape tuning and also we can validate or design by verifying rise time, settling time, overshoot, gain, loss, phase margins and other requirements. In this session dc motors model is completely designed by using control and estimation tools manager. A standard test model as considered is taken for study of AVR and LFC with ANFIS tuning controller.

IV. HYBRID NEURO – FUZZY CONTROL

In this paper the performance evaluation based on different conventional controllers like PI & PID and intelligent controllers like Fuzzy, ANN & ANFIS are used.

ADAPTIVE NEURO FUZZY INFERENCE SYSTEM (ANFIS)

ANFIS stands for Adaptive Neuro-Fuzzy Inference System. The ANFIS controllers are nothing but of combining the ANN and fuzzy controller. ANFIS is about taking a fuzzy interface system to learn the network structure and facilitates.

An error occurs if our ANFISlearning does not complete these constraints. Moreover, ANFIS is specified for the speed of the power system if the speed of the power system is control or main at constant range both the frequency and voltage of the generating power system is maintained.

V.PULSE WIDTH MODULATION

Pulse Width Modulation (PWM) is nothing but of one the modulation technique used in mostly in communication system for encoding the amplitude of the signal and its main purpose is controlling the power supply to various electrical devices mostly in AC and DC motors by using this technique we are going to control the frequency and voltage by controlling the speed of the motor in the generator power system.

A very powerful benefit of using PWM is power loss in the system is very less compare to other modulators. In pulse width modulation speed control works by driving the motor with series "ON/OFF" pulses and varying the duty cycle. By the series ON/OFF condition in fraction of time which reduces speed of the motor and main the frequency and voltage constant.

V.SIMULATION RESULTS AND DISCUSSION

DEVELOPMENT OF THESIMULATION MODEL:

In this section, development of the simulation model of LFC and AVR controlled by ANFIS controller is presented. The complete modelled in Simulink is a feedback control system consisting of the power supply, controllers, comparators, feedback system, rectifier, transformers, PWM, single stage PFC inverter, output and input sources. The block diagram is shown in Fig.6.

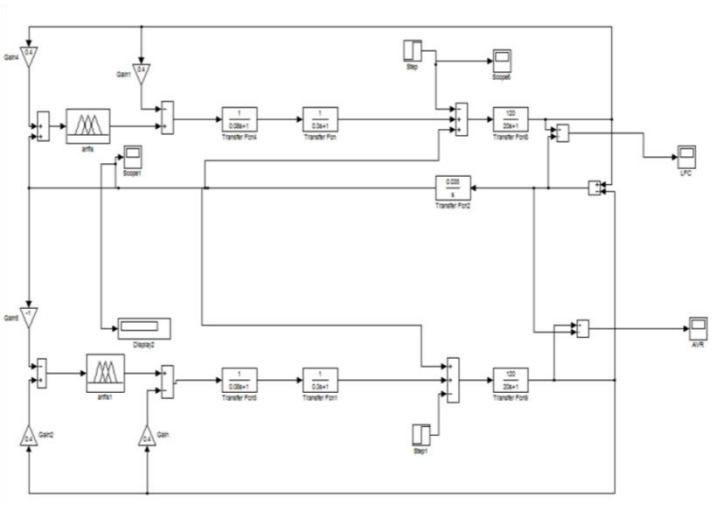

Fig.6. Simulation Block diagram of LFC and AVR

SIMULATION RESULTS:

The designed hybrid learning algorithm based LFC and AVR with PWM and ANFIS controller system is exerted to stabilize frequency in the system study. The simulation results demonstrate the effectiveness of the designed system in terms of reduced settling time, overshoot and oscillation and simulation by MATLAB (R2010a) software. In order to study and analysis the system performance, a disturbance is created in the system.

1. TEST SYSTEM 1: LOAD FREQUENCY CONTROL:

In this case analysis of Load Frequency Control (LFC) system tuned method, PID controller tuned, PWM tuned controller, ANFIStuned controller and comparative analysis of all controller and MATLAB simulation model of all controller shown in Fig.7. The results of proposed ANFIS tuned controller is compared with PID controller, ANFIS tuned controllers. The quality of power supply is determined by constant of frequency. The proposed approach ANFIS tuned controller is better than the other controller like PID controller. It can be concluding that ANFIS controllers are used to minimize the frequency overshoot and stabilization.

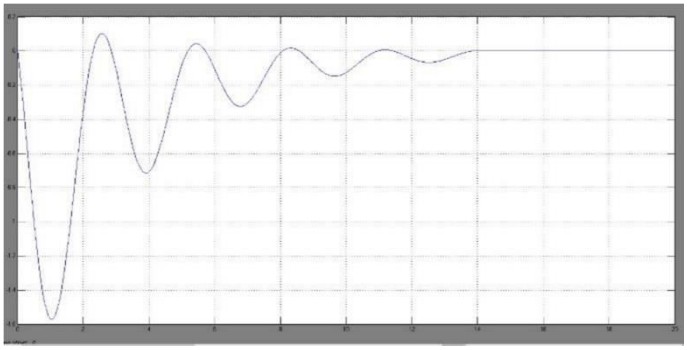

Fig.7. LFC loop response with a simulation time constant T=13.0.

2. TEST SYSTEM 2: AUTOMATIC VOLTAGE REGULATOR:

In this case analysis of Automatic Voltage Regulator (AVR) system tuned method, PID controller tuned, PWM tuned controller, ANFIS tuned controller and comparative analysis of all controller and MATLAB simulation model of all the controllers shown in Fig.8. The results of proposed ANFIS tuned controller and PWM voltage regulator are compared with PID tuned Controller, The quality of power supply is determined by constant voltage. The reliable power supply has the characteristics gives good terminal voltage. The proposed approach ANFIS tuned Controller is better the other controller.

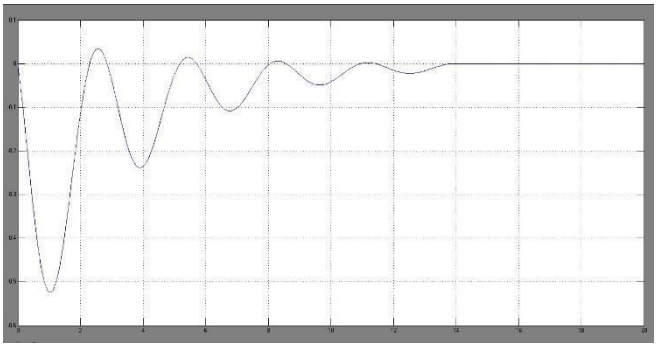

Fig 8. AVR loop response with a simulation time constant T= 13.0.

WAVEFORM COMPARISON:

	Using PID Controller (In sec)	Using ANFIS/PWM (In sec)
Simulation Time Constant for LFC	20.0s	13.0s
Simulation Time Constant for AVR	20.0s	13.0s

VI. CONCLUSION

The MATLAB simulation results of the proposed ANFIS controller is more effective means for improving the performance of the LFC and AVR compared with previous PID controller. The proposed system achieves good performance when compared with other controllers such as PID controllers. The Quality of the power supply is determined by constant of frequency and voltage. The reliable power supply has the characteristics of minimum frequency deviation and voltage response. The terminal voltage and frequency response of AVR and LFC are interact with different proportional gains were analyzed. It can be concluding that ANFIS controller are used to minimize the frequency and voltage overshoot.

VII. REFERENCE

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VIII. AUTHOR'S INFORMATION

Surendhar.A. He received his B.E. in Electrical and Electronics Engineering from Sona college of Technology, Salem, India in 2016. He is currently pursuing M.E. degree in Power System Engineering at Sona college of Technology, Salem, Tamil Nadu, India.