A Research on ANFIS Based Load Frequency Control of Multisource Interconnected Power System

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Abstract— Load frequency control in power system is important as due to change in frequency sensitive equipment in industries can suffer which may lead to breakdown, thus reducing production. Also speed of electrical motor depends upon frequency so their performance alters due to change in frequency. Power system network consists of different capacities transformers. If frequency of supply is reduced, then for maintaining constant voltage, flux has to be increased which causes saturation of transformer core. Also at higher frequency, hysteresis and eddy current losses in motors and transformers are increased. In power system network electricity is generated using multiple sources and these sources are interconnected using transmission lines to increase reliability of the system. Here we achieve load frequency control using three different controlling strategies namely PID, Fuzzy logic controller and ANFIS. Their performances are compared with each other to analyse which of the above strategies suits the best.

Keywords: Load Frequency Control, PID, Fuzzy Logic Controller, ANFIS, Settling Time, Overshoots, Undershoot

I. INTRODUCTION

Power demands are by no means constant and with this change in load, power generation should be changed accordingly to maintain frequency of the system within limits. The control strategy should be such that it helps in achieving the balance of load and generated power rapidly and steady state error, between actual frequency and after being subjected to the changes, should be zero. Also controller should be able to minimize the change in frequency before it gets stabilized.

LFC is one of the most profitable ancillary services of consistent Power System. LFC is very important topic of research and many researchers studied this problem with various combinations of controller and power system models. Control method like PID-C, FLC, adaptive Neural fuzzy interface system (ANFTS), decentralized controller are used to control system frequency. Owing to deregulation of power industry, use of AC-DC tie lines FACTS devices etc control concept also evolved. Most of researchers measured thermal or hydrogenating units in control area. This motivated to take more realistic combination of multisource power generation into consideration in a control area.

II. MATERIALS & CONCEPTS OF LFC

A. *Working of LFC Loops*

In power system the frequency is maintained by changing active power output of generator in accordance with the load. This is achieved by varying mechanical power input fed by prime mover. To do so the steam valve is opened and closed by the hydraulic amplifier amplifying the output of speed governor. Speed governor senses the speed of shaft of the rotor, which is proportional to the output frequency.

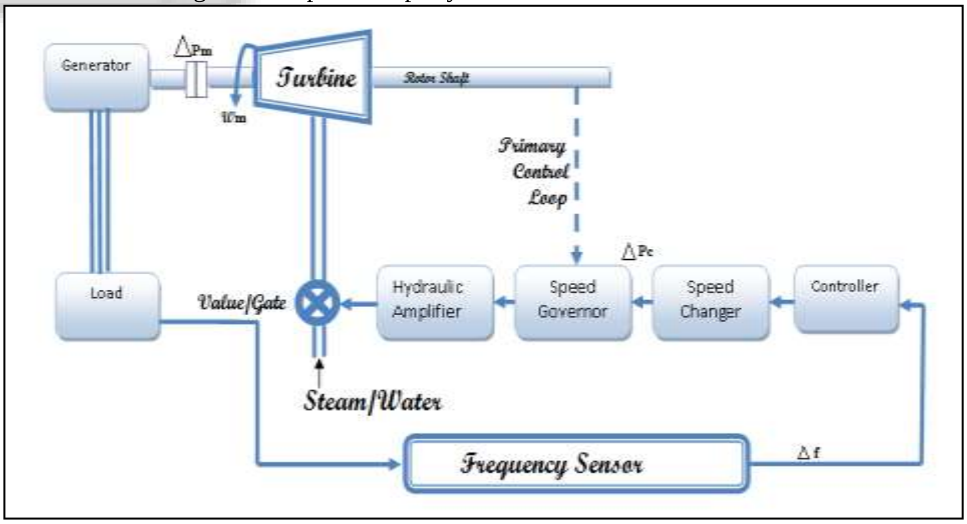


Fig. 1:

B. *Freq Response Modeling*

Frequency response modeling is done by the mathematical model of load frequency control loop which is represented graphically by block diagram employing transfer function blocks for speed governor, turbine and power system.

$$\Delta P_g = \Delta P_c - \frac{1}{R}\Delta f$$

Given that,
ΔP_g is little change in governor command,
ΔP_c is little change in reference power setting

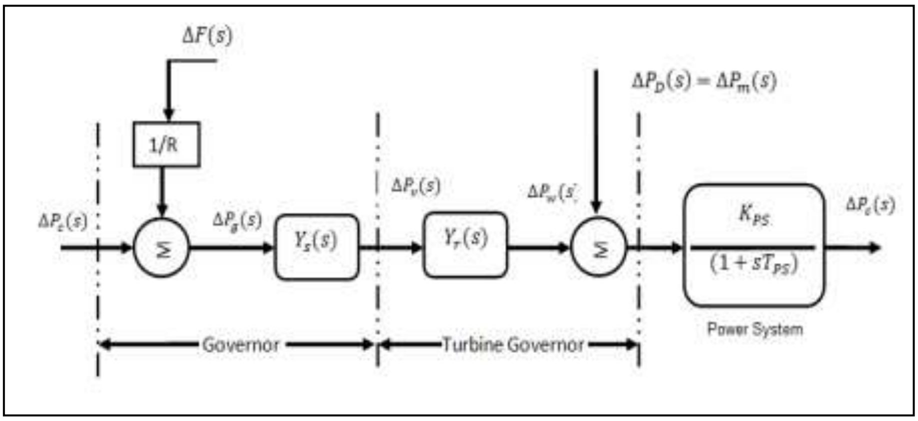


Fig. 2: Linear model of primary LFC loop

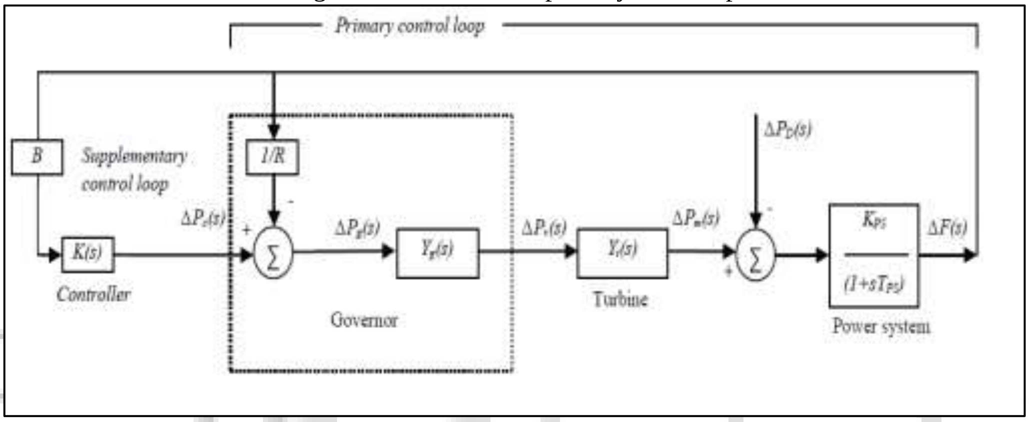


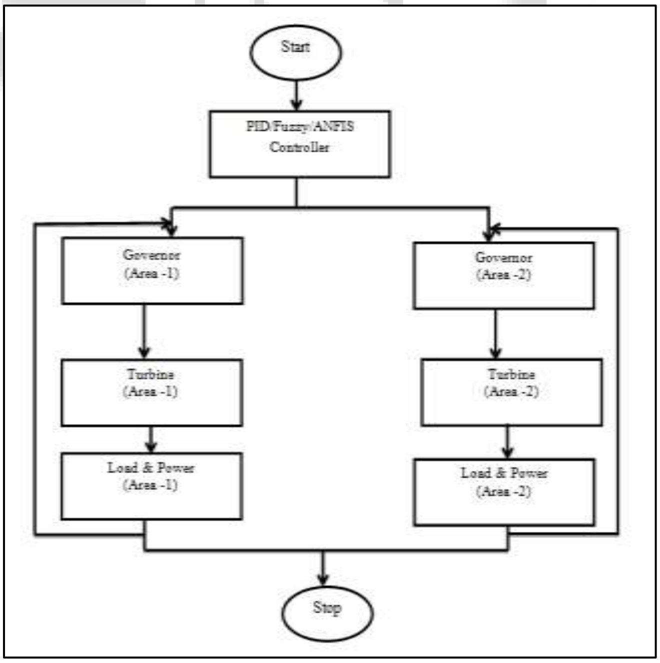
Fig. 3: Linear model with supplementary LFC loop

C. Load Freq Problems

Frequency and speed of system gets changed due to change in load, and then is adjusted according to the characteristics of control strategy employed. If it is required to change frequency manually, the operator can alter speed changer setting to change speed of turbine and thus frequency. Another possibility to compensate for the change in load is by the use of another generating station and tie line, handling the load-active power generation constraint by sharing the load. We get following configuration:

1) If at generation point A or at generation point B, the load is such that it exceeds the generating capacity of the respective generator then the other generating station will satiate the demand using tie to have consistent frequency in all the area irrespective of load, then this is called flat frequency control.
2) If constant power flow is maintained through the transmission line without overloading tie line, then this is known as tie bias control.
3) If both of the generator regulate their generation according to change in load at both the points A and B, in order to hold frequency steady then this is known as parallel freq control.

III. PROPOSED TECHNIQUE



IV. CONTROL TECHNIQUE

In this thesis, performance evaluation is based totally on one-of-a-kind conventional controllers (PID) and smart controllers (like Fuzzy and ANFIS) with exclusive gain scheduling has been performed.

A. PID-C

PID controller is the combination of proportional, integral and derivative control system. A PID controller has the advantages of all the three i.e. has zero steady state error, fast controlling action and sentive for sudden changes as well.

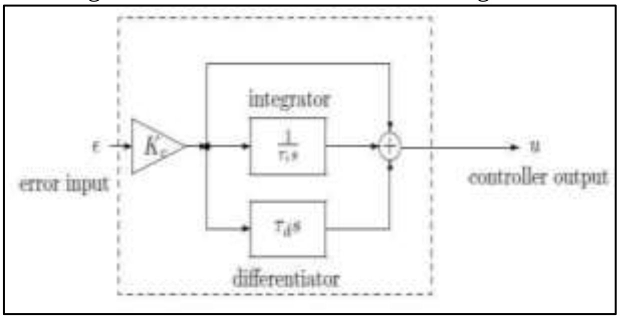


Fig. 4: A PID-C system

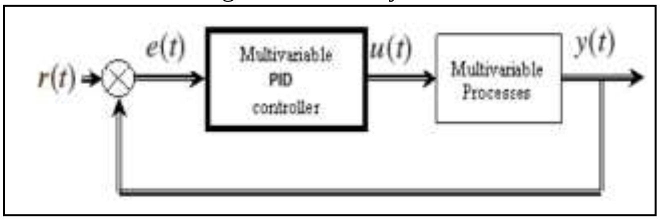


Fig. 5: A structure of a PID-C system

B. Fuzzy logic controller

A fluffy practical insight based savvy controller is intended to encourage smooth activity and substantially less oscillatory while machine is exposed to a startling burden change. FLC depends absolutely on an intelligent machine alluded to as FL that is a great deal closer in soul to human addressing and regular language than traditional consistent structures

1) Stage 1: Fuzzification: Convert old style data or fresh data into fluffy records or MFs.
2) Stage 2: Fuzzy Inference Process: Combine MFs with oversee guidelines to determine fluffy yield.
3) Stage 3: Defuzzification: Use explicit techniques to ascertain each related yield and situated them directly into a table: investigate table. Get yield from research table dependent on contemporary contribution during a product

C. ANFIS method

ANFIS is a set advantage controllers for LFC are structured at ostensible running condition and neglect to offer top notch control generally speaking execution over a wide assortment of working circumstances. In this way, with a reason to keep framework generally speaking execution close to its surest, it's far appropriate to music running conditions and utilizes something like date requirements to process oversee benefits. Open transmission get passage to and advancing of more prominent mingled organizations for time, transmission and dissemination

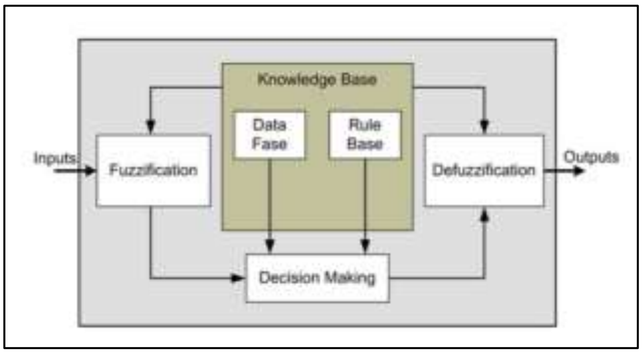


Fig. 6: Fuzzy Inference Systems

All the three controllers are analysed for load frequency control using MATLAB. Output comparison is shown below

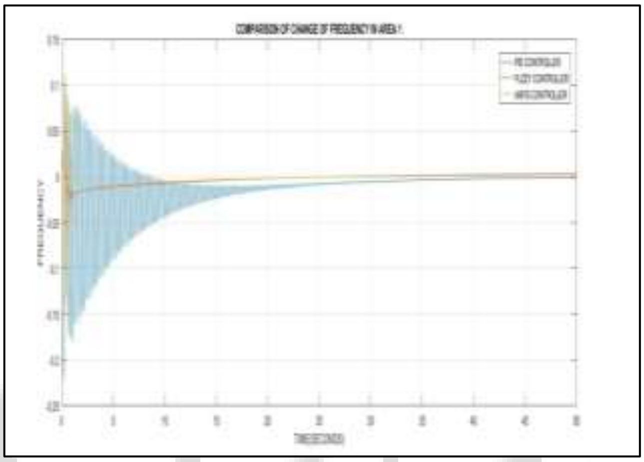


Fig. 7: Comparative Analysis of Area Loop – I Frequency Variation using PID, Fuzzy and ANFIS Controller

V. CONCLUSION

Many research deals with LFC have been accounted for as of late. Still there is much space for further improvement and expansions of LFC methodologies. In this proposition an ideal yield criticism controller structure strategy is proposed for LFC. Frequency variations reaction of zone and generator yield control deviation reaction to 1% step burden bothers have been acquired. yield criticism controller gives better f deviation reaction having generally littler pinnacle overshoot and lesser ST with zero SSE when contrasted with full state input controller reaction. The net Conclusion for the research is

– The rise time of PID, Fuzzy and ANFIS Controller is 10, 8 , 5 sec respectively.
– Peak time of PID, Fuzzy and ANFIS Controller is 30, 13, 9 sec respectively.
– Setting time of PID, Fuzzy and ANFIS Controller is 40, 30, 20 sec respectively.
– The percentage overshoot is 0.8%, 0.1% and 0.032% respectively.
– The steady state error is 0.4% 0.02% and 0.001% respectively.

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