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Load Frequency Control of two area System with PI &Fuzzy controller

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ABSTRACT

In the recent time the fuzzy logic controller to control a nonlinear process has received wide attention. A single generator unit feed a power line to various users whose power demand can vary over time to time, is called a nonlinear process. If there is a change in load demand then there is a change in the frequency of the generator.This thesis presents a procedure to design controller based on fuzzy logic and PI to control the load frequency variations in on efficient manner. Two types of plant are studied – single area thermal plant, two area thermal- thermal plant. In this thesis work Adaptive fuzzy logic gain scheduling controllers are designed which change the controllers parameters according to variations. The results show the superiority of the fuzzy logic and gain scheduling over the PI controller. In the simulations a linear model of power system is used.

The main advantages of fuzzy reasoning approach are -

1. It provides an efficient way of coping with imperfect information, especially imprecision in available knowledge.

2. It allows the use of linguistic expression to describe the behavior of the system or the control actions. Using this property it is possible to imitate the actions of operators.

3. Controllers based on fuzzy logic are inherently nonlinear and are thus able to perform control actions which are not possible with a purely linear approach.

AGC Schemes

The first attempt in the area of AGC has been to control the frequency of a power system via the flywheel governor of the synchronous machine. This technique was subsequently found to be insufficient, and a supplementary control was included to the governor with the help of a signal directly proportional to the frequency deviation plus its integral. This scheme constitutes the classical approach to the AGC of power systems. Following that, suggestions for dynamic modeling for LFC are discussed thoroughly It is based on the experiences with actual implementation of AGC schemes, modifications to the definition of ACE are suggested from time to time to cope with the changed power system environment . Since many presently regulated markets are likely to evolve into a hybrid scheme, and some deregulated markets are already of this type (e.g., Norway).

LOAD FREQUENCY CONTROL: SINGLE AREA POWER

Load Frequency Control (LFC) is being used for several years as part of the AGC scheme in electric power systems. Whenever there is a load change in the interconnected power system, frequency of the system changes from its nominal value. One of the objectives of AGC is to maintain the system frequency at nominal value.

A Load Frequency Control in a deregulated electricity market should be designed for different types of possible transactions, such as Poolco based transactions, bilateral transactions and combination of these two. AGC required for Poolco based transactions implemented by the SO utilize an integral controller. A method to find the optimum parameter for this type of controller *for a* two-area system of identical rating has been proposed. In a practical power system, there may his more than two areas and each of the areas may have different ratings.

The active and reactive power demands are never steady and they continually change with the rising or falling trend of load. There is a change in frequency with the change in load .the change in frequency causes many problems such as

- Most AC motors run at speeds that are directly related to frequency, the speed and induced electro motive force (e.m.f) may vary because of the change of frequency of the power circuit
- when operating at frequencies below 49.5 Hz ; some types of steam turbines, certain rotor states undergo excessive vibration
- The change in frequency can cause maloperation of power converters by producing harmonics
- For power stations running in parallel it is necessary that frequency of the network must remain constant.

In modern large inter connected systems manual regulation is not feasible and so automatic generation and voltage regulation equipment is installed in each generator. The integral and proportional - integral (PI) controller o the regulation by taking care of small changes in load demand without frequency and voltage exceeding the prescribed limit(+49.5 Hz) **Automatic Generation Control: Single-Area System**

In a single area system mechanical power is produced by a turbine and delivered to a synchronous generator serving different users. The frequency of the current and voltage waveform at the output of the generator is mainly determined by the

turbine steam flow. It is also affected by changes in user power demands that appear, therefore, as electric perturbations. If, for example, the electric load on the bus suddenly increases, the° generator shaft slow down, and the frequency of the generator decreases. The control system must immediately detect the load variation and command the steam admission valve to open more so that the turbine increases its mechanical power production counteracts the load increases , and bring the shaft speed and hence the generator frequency back to its nominal value.

Modeling of the Governor

Let we assume that the system is operating under steady state condition, i.e., the linkage mechanism is stationary, pilot valve is closed, the steam valve is opened by a definite magnitude, turbine is running at constant speed and the turbine output is balanced generator load. Thus the nominal conditions are

Power delivered $= P_G^0$

Speed $= \omega_0$

Frequency $= f_0$

Prime mover value position $= X_E^0$

Let us change the speed changer to command a power increase ΔP_c [ΔP_{ref}]. The speed changer movement gives rise to linkage point "A' moves downwards a small distance ΔX_A.

It can be established $\Delta X_A = K\ \Delta P_C$

The link point 'C' will move upward because of linkage (A-B-C) action. Let it be ΔX_c . Further, the link point 'D' moves the piston in pilot servo (V), resulting in higher pressure oil flow in the upper part of the main piston. The piston moves downward by an amount ΔX_D and the steam valve opening increases. It increases the torque developed by the turbine. This increased torque increases the speed of generator, i.e., frequency (Δf). This change of speed results in the outward movement of fly ball of the speed regulator. Thus the link 'B' moves slightly downward a small distance ΔX_B.

Due to the movement of link point B, the link point 'C' also moves downward by an amount AX_C which is also proportional to Δf . Thus the net movement of link point C is

$$\Delta X_C = \Delta X_C' + \Delta X_C''$$

$$-X_C'(I_{AB}) = X_A(I_{BC})$$

$$-\Delta X_C' = \frac{I_{BC}}{I_{AB}} \Delta X_A$$

$$-\Delta X_C' = K_1 \Delta P_C$$

Where

$$K_1 = \frac{I_{BC}}{I_{AB}} K \text{ and } X_C' = K_2 \Delta f$$

Thus it can be written as $\Delta X_C = -K_1 \Delta P_C + K_2 \Delta f$

Again

$$\Delta X_D = \Delta X_D' + \Delta X_D''$$

$$\Delta X_D'(I_{CD} + I_{DE}) = \Delta X(I_{DE})$$

$$\Delta X_D'' = (I_{CD} + I_{DE}) = \Delta X(I_{CD})$$

Thus we can write

$$\Delta X_D = K_3 \Delta X_C + K_4 \Delta X_E$$

Now if an assumption is made that the flow of oil into the servo-motor is proportional to position ΔX_D of the pilot valve V , then the movement ΔX_E of the piston can be expressed as-

$$\Delta X_E = \Delta X_V = K_5 \int (-\Delta X_D) dt$$

Taking laplace transform of above equations-

$$\Delta X_C(s) = -K_1 \Delta P_C(s) + K_2 \Delta f(s)$$

$$\Delta X_D(s) = K_3 \Delta X_C(s) + K_4 \Delta X_E(s)$$

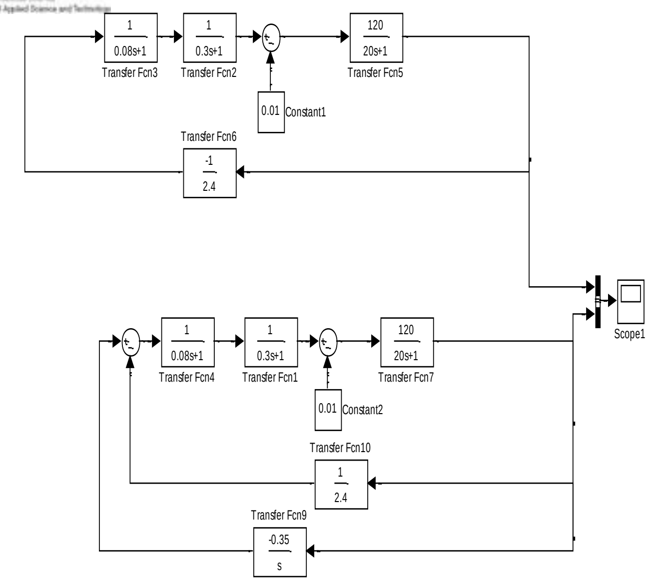
$$\Delta X_E(s) = -K_5 \frac{1}{s} \Delta X_D(s)$$

CONCEPT & DESIGN OF FUZZY LOGIC

Fuzzy logic is another form of artificial intelligence, but its history and application are more recent than expert system. It is argued that human thinking does not always follow crispy "YES" - "NO" logic, but it is often vague, uncertain, and indecisive. Lofty Zadesh originated the fuzzy logic or fuzzy set theory in *1965. Fuzzy* logic has been recently applied in process control, modeling, estimation, identification, diagnostics, stock market, prediction, agriculture, military science and so on. Fuzzy logic, unlike Boolean or crispy logic, deals with problems that have vagueness, uncertainty, imprecision or qualitative ness. In convention set theory based on Boolean logic, a particular object or variable is either a member (logic 1) of a given set or it is not (logic 0). On the other hand, in fuzzy set theory based on fuzzy logic, a particular object has a degree of membership in a given set which may be anywhere in the range of 0 to 1, The basic property like union (OR), intersection (AND) and complement (NOT) of Boolean logic are also valid for fuzzy logic.

Use of Fuzzy Logic

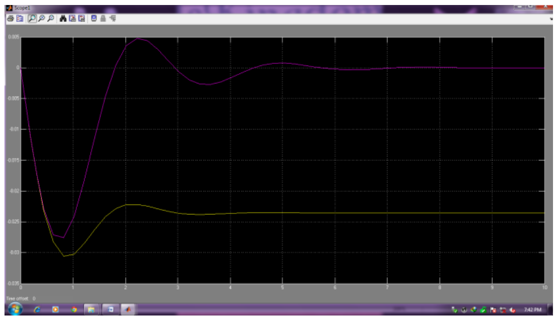
There are so many uses of fuzzy logic in the present life. Fuzzy logic is conceptually easy to understand, flexible, tolerant of imprecise data. Fuzzy logic can model non linear functions of arbitrary complexity. Fuzzy logic can be built on top of experience of experts. Fuzzy logic can be blended with conventional control technique. *Fuzzy* systems don't necessarily replace conventional control methods. In many cases fuzzy systems augment them and simplify their implementation. Fuzzy logic is based on natural language. The basis of fuzzy logic is the basis for human communication. The observation explains many of the other statements about the fuzzy logic.



simulink model of Single area thermal plant with and without Controller

Upper model-without controller

Lower model- with PI controller



Blue curve-with PI Controller

Yellow curve- without controller

Without controller frequency never settle down

It means Δf never equqls to zero.

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