UNDER FREQUENCY LOAD SHEDDING USING ADAPTIVE NEORO FUZZY INFERENCE SYSTEM

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ABSTRACT

In this paper under frequency load shedding method is proposed using adaptive neuro fuzzy inference system. The fuzzy If-then rules govern the functioning of load shedding in different conditions. The system is simulated on fuzzy tools and results are generated. The final result shows a training error equal to 0.0169 which is very close to the tolerance level. Using fuzzy logic control makes the implementation of the system much more practical which is the first & foremost goal. Adaptive Under-Frequency Load Shedding is an accurate method which sheds the right amount of load from the system during instability. Under Frequency Load shedding works when the frequency of the system drops to a value lower than normal.

Keywords: Fuzzy Logic Control, Neural Networks, Training Error, Neuro Fuzzy Inference System

I. INTRODUCTION

1.1 Present Scenario

In today's world there is a great problem of electricity supply meeting the demand of the people thus load has to be shed intentionally in order to reduce burden on the generator end. Intelligent Load shedding helps understanding the problem due to which the load needs to be shed and also gives the exact amount of load to be shed for the proper working of the interconnected systems.There are various technologies proposed for load shedding:

1. Breaker Interlock load shedding
2. Under frequency relay load shedding
3. Programmable logic controller based load shedding, so on and so forth.

1.2 Problem with Conventional Methods of Load Shedding

Problem faced by conventional methods are:

1. There is only one stage of load shedding
2. More load is shed than required
3. Modification to system is costly
4. Slow response time
5. Analysis knowledge is always lost

1.3 Solution Proposed in this Paper

Solution to these problems is an intelligent load shedding method which is proposed in this paper using "NeuroFuzzy Inference System". Technologies utilized in the intelligent load shedding method are:

1. Fuzzy Logic Based System: The if-then rules of fuzzy logic are used. Based.
2. On the rule base the amount of load to be shed is decided.

1.4 Advantages Over Other Systems

Fuzzy logic control is very flexible and the use of adaptive neuro fuzzy logic provides the facility of learning. Here the back propagation algorithm is used which is used to deduce the output. Thus because of fuzzy system the use of other sensors is not important. Fuzzy gives the exact amount load to be shed and the error percentage is very low. The training and testing of data is also possible and the output is given by the trained data.

II. LITERATURE REVIEW

This research paper consist of two important aspect first is automatic under frequency load shedding and other is neuro fuzzy inference system. Power system stability is a very important aspect of power generation, there are various factors on which power system stability depends but here in this research paper we have consider two inputs- (i) Input frequency, (ii) Change in input frequency. Frequency is a continuous changing variable which is a function of the system generation and the supply. Many short circuits, load growth, generation shortages and other faults disturbs the voltage and frequency stabilities of the system. This instability causes the large scale blackouts and done serious damages to the equipment. To prevent such condition certain amount of load is required to be shed so as to keep the frequency in between normal working range.Now the first aspect of our research paper is under frequency load shedding which is defined as the set of controls which results in shedding the load in the power system. To control the frequency drop and maintain the frequency a certain amount of load is shed. Basic principles in the power system operation are frequency and voltage stabilities [1]. So usually under normal condition total generated power is equal to the sum of running load plus all real power losses. Normally load shedding is simply a balance maintaining between demand and generation. In Indian power generation takes place at 50Hz. So to avoid any blackout it is important to maintain the frequency at 50Hz. On the both ends of see-saw there is demand and generation so, when there is a slight increase in demand than generation than there is slight variation in frequency. Now suppose a large portion of generation is removed than there will be large variation of f.0/requency from 50Hz which can cause blackout. Now in these case AUFLS block come into play. So to maintain the balance between demand and generation supply to the AUFLS block is cut till the frequency reaches its normal value. Power system frequency is a continuous changing variable which is a function of generated supply and load demand in the power system. Recently the main challenges of electric power utilities is power system blackouts [2]. Power system blackouts are like chain reaction which runs from one region to other region if they are not controlled. Extreme system disturbances can result in uncontrolled output and isolation of areas causing formation of electrical islands. If such an area is under generated, it will experience a majorreduction in frequency. Unless sufficient generation with ability to increase output is available, the frequency decline will be largely determined by frequency sensitive characteristics of loads [3]. To execute the operation of extended area under frequency load shedding is used. Load shedding scheme is employed to cut-off certain load in order to supply by using the available amount of generation. Under frequency load shedding is a common practice for electric utilities for preventing frequency drop in power

systems following a disturbance [4]. Load shedding schemes can be grouped into three main categories: traditional, semi adaptive and adaptive [5]. Traditional scheme is as its name suggest is simple and used by most utilities. The semi-adaptive method calculates the rate of change of frequency whenever the system reaches a certain threshold frequency. In [6] an adaptive methodology is given for the setting the under frequency based relays, based on the initial rate of change of frequency at the relay. In [7]a method using both frequency and voltage changes is presented. In [8] an adaptive scheme that uses both frequency and the rate of change offrequency measurement to dynamically set under frequency relays is presented.

III. DESIGN ASPECT OF INTELLIGENT LOAD SHEDDING

A. Fuzzy logic based system (main working concept)

Table I. Working Concept

FREQUENCY	PREFERNCES
If frequency is near 47.5 to 49.5	Load needs to be shed according to the frequency range and df/dt

3.1 Input Variables

Frequency and rate of change of frequency (df/dt)

Frequency: (range from 47.5 to 49.5)

Low

Very low

Very extra low

Extra low

rate of change of frequency (-6pu to 6pu)

High positive

High negative

Low positive

Low negative

3.2 Output Variables

The amount of load to be shed i.e. in our case the outputs are as follows:

Small shed

Very small shed

Big shed

Very big shed

3.3 HOW RULES WERE CREATED:

	LOW	V LOW	EXT LOW	VEXT LOW
HN	SSHED	BSHED	BSHED	VBSHED
LN	SSHED	SSHED	BSHED	VBSHED
HP	VSHED	VSHED	SSHED	SSHED
LP	VSHED	VSHED	VSHED	VSSHED

HN means HIGH NEGATIVESSHED means SMALL SHED

LN means LOW NEGATIVEVSSHED means VERY SMALL SHED

HPmeans HIGH POSITIVEBSHED means BIG SHED

LP means LOW POSITIV VBSHED means VERY BIG SHED

Thus 16 rules are formed such that whendf/dt is HN and frequency is low the required amount of shed is (small shed) and so on.

IV. SIMULATION RESULTS

The simulation work is done on the MATLAB fuzzy toolbox. The rule base is defined on the Sugeno with the information of input and output parameters and the learning of the system is done using the ANFIS.

4.1 Various STAGEs in SIMULATION

1. First the input and output parameters are defined.

2. In the second step rules are defined on the Sugeno model.

3. Then by the help of a MATLAB program, simulation of defined rules is done and set of values are generated.

4. These values are utilized to train the system.

1. First stage: defining input and output parameters. First stage of simulation is shown in the Fig1 & Fig2. Here various input and output parameters are defined with their membership functions on FIS.

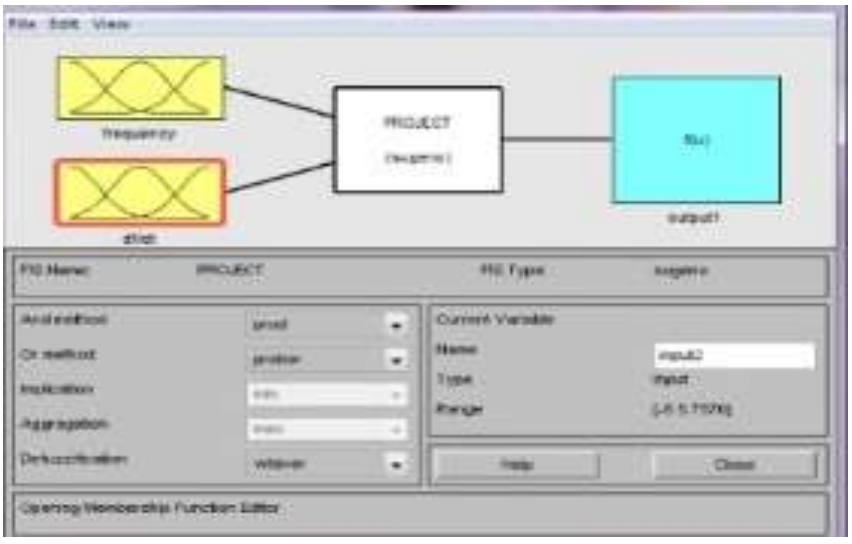

Fig1. Input and Output Parameters

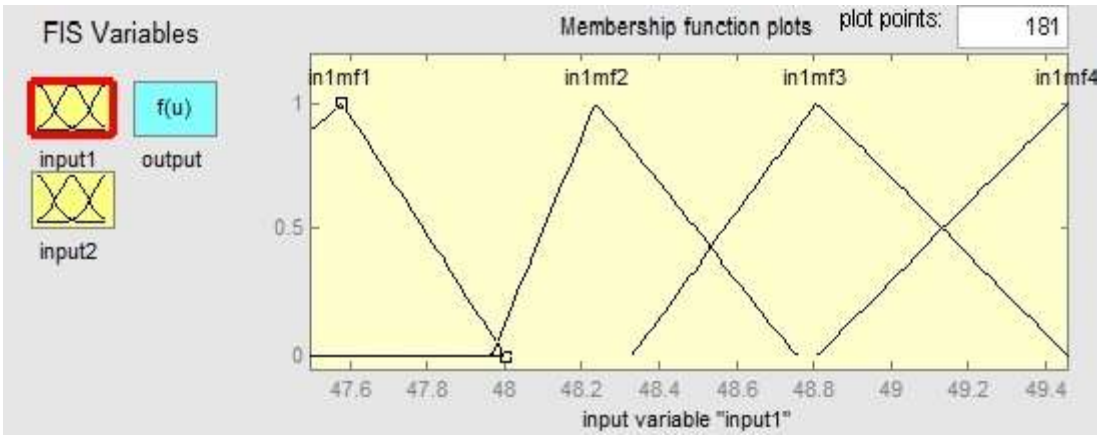

Fig 2. Membership Functions of Input and Output Parameters

2. Second Stage: Defining the rules

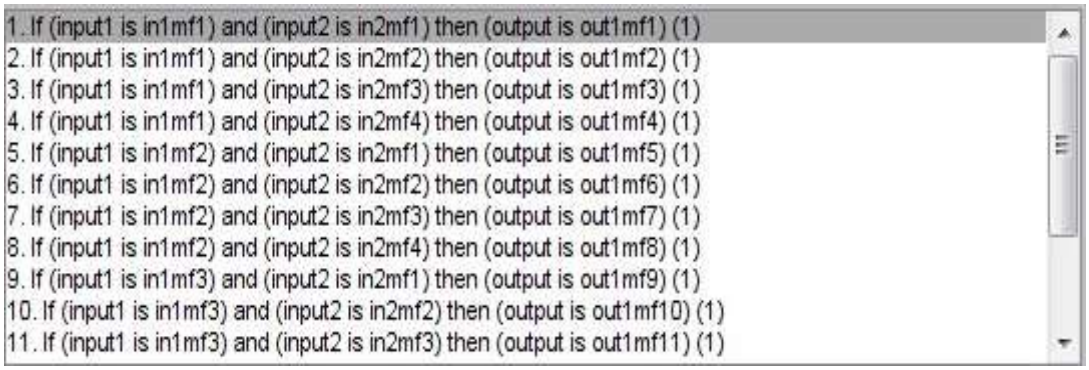

Fig3. Shows the Rule Base Defined on FIS

3. Third Stage: Program simulation on mat lab

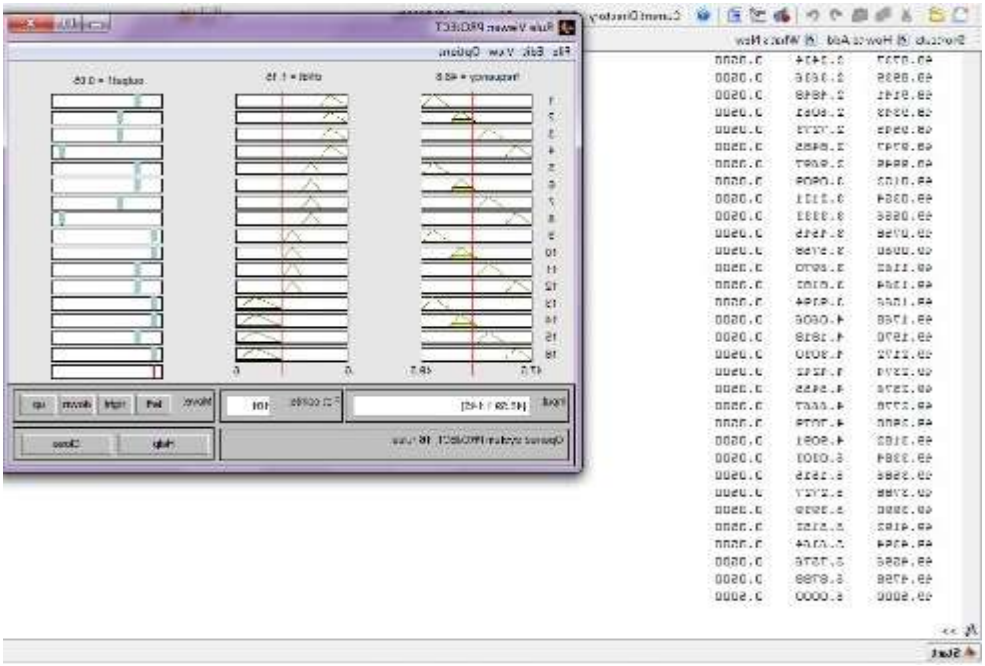

Fig4. Program Simulation Result

4. Fourth stage: Final training &error reduction

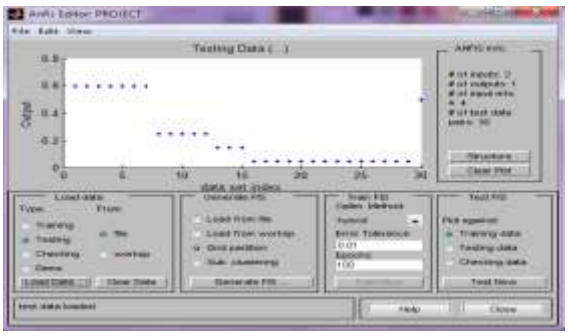

Fig 5. Testing Data

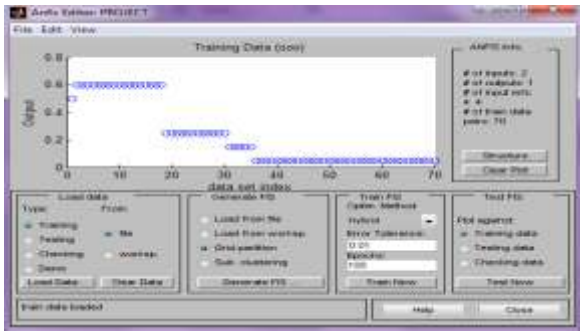

Fig6. Training Data

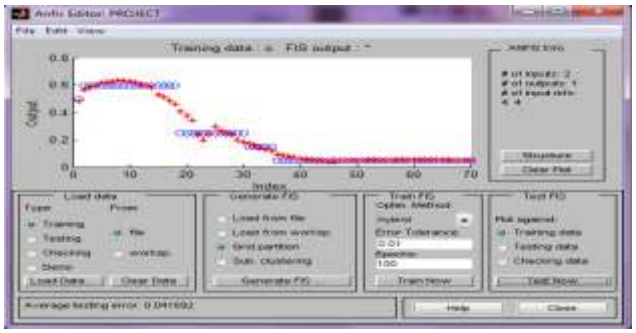

Fig 8. ANFIS info After Training

After testing the following data, comprising of all the information is generated on the MATLAB window:

```
ANFIS info:
    Number of nodes: 53
    Number of linear parameters: 16
    Number of nonlinear parameters: 24
    Total number of parameters: 40
    Number of training data pairs: 70
    Number of checking data pairs: 0
    Number of fuzzy rules: 16


Start training ANFIS ...

   1      0.0416922
   2      0.0418605

Designated epoch number reached --> ANFIS training completed at epoch 2.
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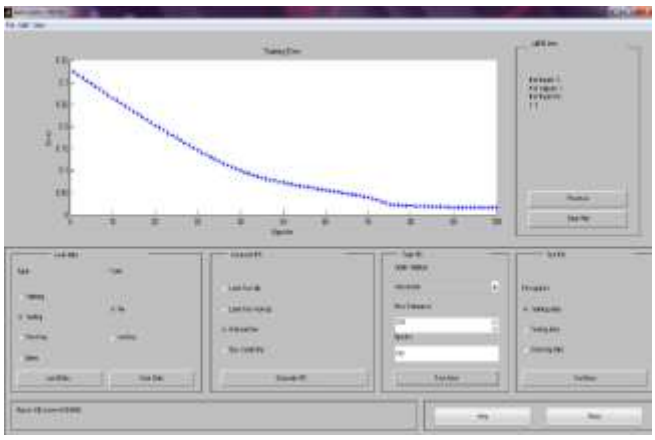

Fig9. Training Error

Figure 9 shows the error generated during the training of the system. The main objective here is to reduce the error by certain modifications such as modifications in rule base or in the generating functions.

Error tolerance: 0.01

Epoch: 100

Error: 0.0169

V. CONCLUSION

India is a highly populated country; frequency variation is the major problem that we are facing today. So due to the shortage of electricity load shedding is very important for proper distribution of power. Now due to the increasing demand of power supply automatic load shedding is important to relieve the loaded instrument before any damage happens to it or tripping of line takes place. So all this can be possible with the help of automatic load shedding. As we can see in our research paper that load shedding can be done by various ways but the most effective way doing it is by using adaptive neuro fuzzy interference system. ANFIS system helps us to digitize the working of a power system. It helps us to understand the change in output with the variation in frequency, so we can easily understand the condition of our system. All this can be impossible with the conventional load shedding methods. Conventional load shedding methods are not that efficient and also a bit slow as compared to ANFIS system.The existing methods such as Breaker inter locking system; Under Frequency Relay Load Shedding and PLC based controllers are used for the load shedding. These methods are time consuming and also shed excess amount of load. Compared to other under frequency load shedding control methods, the ANFIS method shows the advantages like lower value of load shedding, quick response, saving more amounts of energy and benefiting more consumers.

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