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Depiction and Exertion of Power Load Stabilizing Adopting Fuzzy Logic

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Abstract: the nature of the load is changing day by day and the demand is also changing accordingly. Necessity is the mother of invention. In the last ten years scientific inventions have brought a lot of change in all the equipment of our daily life, acquiesce to witch electricity demand has also enhanced considerably. With the advancement in every field, the dependence on electricity is constantly increasing and is has becomes necessary to spend life easily. Mainly there are three stages of power system i.e. generation, transmission and distribution. Many methods are being used to enhance the efficiency and reliability of all the stages of power system, thereby the power supply can be provided to the local & industrial consumers without any interruption.
Index Terms: power load, power system, load management, electricity demand, FUZZY LOGIC.

I. INTRODUCTION

Different types of circuit breakers and switches are used to maintain the smooth flow of distribution network. As the demand of power supply can change drastically depending upon the load requirement, the control and monitoring of these accessories is required for these switches and CB as they are imposed to the different climatic conditions [2]. For fast operations of the distribution network, modern technologies like signaling, computers, and communication are used. These automatic systems need to be control and monitored with the help of human machines interface. The loads are modifying with the help of these computer aided power system by automatic opening and closing of the switches and CBs which loads towards Load Balancing [1].

Nowadays load balancing is used drastically to enhance the system security and to degrade the distribution feeder losses. Large number of switches is there which are normally closed and normally open. By altering the position of these feeder switches the load currents can be transfers from one feeder to another depending upon the requirement [3][4]. In Chhattisgarh, to maintain the load current in the feeder, the connection phase of some feeders are changed according to the requirement in guidance of some experts pupil, who analyze the situation and give the command. But, this process is somewhat time consuming and sometime leads to improper results. Here in this project, we propose the use of fuzzy logic based load balancing system for load change implementation as a procedure to perform the feeder load balancing.

II. PROBLEM IDENTIFICATION

Demand for power supply changes from individual to individual and we are not sure that the load demand for any particular firm or personnel remains constant. Excessive load on any phase leads to distortion or malfunctioning of the equipments associated with it. Similarly very less load causes decreases in efficiency. Thus, the load demand should be up to a limit, if not it leads to decrease in the efficiency of the system. To maintain the steady operation of the power system, balancing the load in the phase is required. It is desirable to maintain similar load on all the three phase, time to time checking of load requirement is very necessary so that the system is put into a condition which fulfills the required load. MATLAB provides a number of toolboxes. The load can be transfer from one point to another with the help of switches. The switches can connect and disconnect the load at any time. By operating the switches the load can get attached with the system or can be detached according to the need. We use the fuzzy logic toolbox of MATLAB as a tool to balance the load in the 3 phase system. With

the help of fuzzy logic we can reach to a position where it can be easily determined as how much load we need to add or subtract from the power system to maintain a favorable condition which is acceptance by all. We are using fuzzy Logic as it is easy to implement, and work on simple language.

III. METHODOLOGY

Introduction of Power System

Demand of electrical energy is increasing day by day. The number of consumes are increasing still at a faster rate. And every effort is made to fulfill their need of electricity. An Electrical power system consists of generation, transmission and distribution units.

Load can be resistive, capacitive or inductive type. Sometimes a combination of these loads is also used. In a power system the load can be of three types. These are as follows:-
1. Industrial
2. Residential
3. Commercial

Fuzzy Logic Controller

Fuzzy Logic provides a more efficient and resourceful way to solve Control system. It is able to be applied to control systems and other applications in order to improve the efficiency and simplicity of the design process**.** A number of assumptions are implicit in a fuzzy control system design. A typical fuzzy logic controller is shown in figure 1
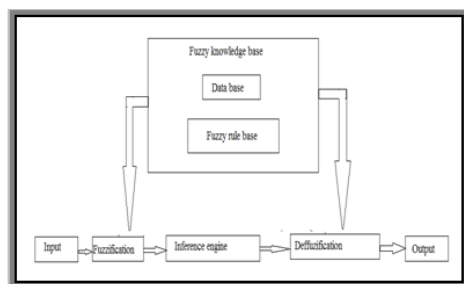

Figure 1 fuzzy logic controller

The basic components of fuzzy logic controller are: There are five principal elements to a fuzzy logic controller:
• Fuzzification module (Fuzzifier).
• Knowledge base.
• Rule base.
• Inference engine.
• Defuzzification module (defuzzifier).

Advantages of Fuzzy Logic

• Fuzzy logic is conceptually easy to understand. The mathematical concepts behind fuzzy reasoning are very simple. Fuzzy logic is a more intuitive approach without the far-reaching complexity.

• Fuzzy logic is flexible.
With any given system, it is easy to layer on more functionality without starting again from scratch.
• Fuzzy logic is tolerant of imprecise data.
Everything is imprecise if you look closely enough, but more than that, most things are imprecise even on careful inspection. Fuzzy reasoning builds this understanding into the process rather than tacking it onto the end.

• Fuzzy logic can model nonlinear functions of arbitrary complexity.

Properties-The properties of fuzzy set is tabulated as follows:

Commutativity	$A \cup B = B \cup A$	$A \cap B = A \cap B$
Associativity	$A \cup (B \cup C) = (A \cup B) \cup C$	$A \cap (B \cap C) = (A \cap B) \cap C$
Distributivity	$A \cup (B \cap C) = (A \cup B) \cap (A \cup C)$	$A \cap (B \cup C) = (A \cap B) \cup (A \cap C)$
Idempotence	$A \cup A = A$	$A \cap A = A$
Identity	$A \cup \phi = A$ & $A \cup X = X$	$A \cap \phi = \phi$ & $A \cap X = A$
De Morgan's Laws	$(A \cup B)^c = A^c \cap B^c$	$(A \cap B)^c = A^c \cup B^c$
Absorption Laws	$A \cup (A \cap B) = A$	$A \cap (A \cup B) = A$
Transitivity	$A \subseteq B \subseteq C \Rightarrow A \subseteq C$	

Involution	$(A^c)^c = A$	
Law of Excluded Middle	$A \cup A^c \neq X$	(Law of excluded middle do not hold for fuzzy sets)
Law of Contradiction	$A \cap A^c \neq \phi$	(Law of Contradiction do not hold for fuzzy sets)

Table 1 properties of fuzzy set

Balancing load using Fuzzy Logic toolbox

So far we are considering a three phase system, where each phase is connected with a number of one hundred fifty loads. Thus, overall there are 450 loads connected to the distribution

feeder, where each load is connected to any one of the phase. We are designing the fuzzy logic controller which gives the amount of load to be subtracted or added to the phase to maintain the system in a reliable condition. The designing is done up to a level of 900 kW because after that balancing load is not possible as its overloading is just double than its maximum possible loading. At this situation, to avoid complete blackout and distortion of cables and transformer the load is to be removed from the system.

Variable define-We write fuzzy in the command window of MATLAB and after writing we press enter, we see the window of fuzzy logic is opened. Now, we have to assign the name to the input and output. Our input is the load, which is the average of all the three phases load, which is the sum of difference between each of two phase load divided by three. The output is named as change. Since, the load and change are the input and output variable they are expressed in kilowatt.

The steps to perform the balancing using fuzzy are as follows:-
Step 1 To create the input variable and define the membership function.   The table and figures are as follows:-

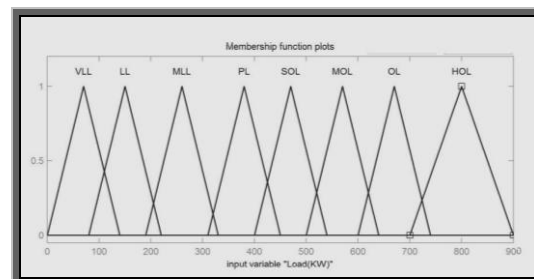| S. No.	Input(Load) Description	Fuzzy Nomenclature	KW Range
1	Very Less Load	VLL	0 to 140
2	Less load	LL	80 to 220
3	Minimum Less Load	MLL	190 to 330
4	Perfectly Load	PL	310 to 450
5	Single Over Load	SOL	400 to 540
6	Medium Over Load	MOL	500 to 640
7	Over Load	OL	600 to 740
8	Heavily Over Load	HOL	700 to 900

Table no. 2 Input variables

Figure 3 input membership plot of fuzzy logic

Step 2 The output named change is assigned the values and we use eight membership function for these. The table and the figure are as follows:-

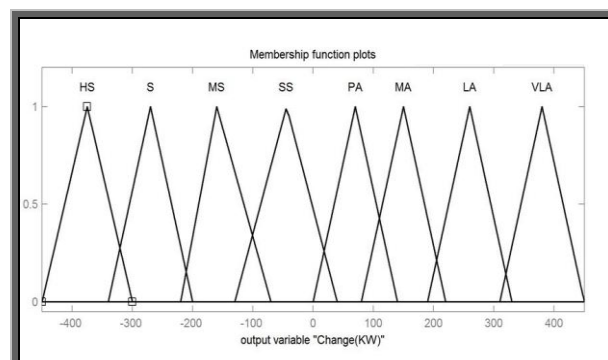| S. No.	Input (Load) Description	Fuzzy Nomenclature	KW Range
1	High Subtraction	HS	- 450 to – 300
2	Subtraction	S	-340 to -200
3	Medium Subtraction	MS	-220 to -70
4	Slight Subtraction	SS	-115 to 40
5	Perfect Addition	PA	0 to 140
6	Medium Addition	MA	80 to 220
7	Large Addition	LA	190 to 330
8	Very Large Addition	VLA	310 to 450

Table no. 3 Output variables

Figure 4. output membership plot of fuzzy logic

Step 3 Fuzzy IF – THEN rules – fuzzy rules takes the form IF (condition) and THEN (actions), where conditions and actions ate linguistic variables respectively. The rules are as follows:-

Rule No.	Rule Description
1	If Load is VLL then Change is VLA
2	If Load is LL then Change is LA
3	If Load is MLL then Change is MA
4	If Load is PL then Change is PA
5	If Load is SOL then Change is SS
6	If Load is MOL then Change is MS
7	If Load is OL then Change is S
8	If Load is HOL then Change is HS

Table no. 4 fuzzy rule base

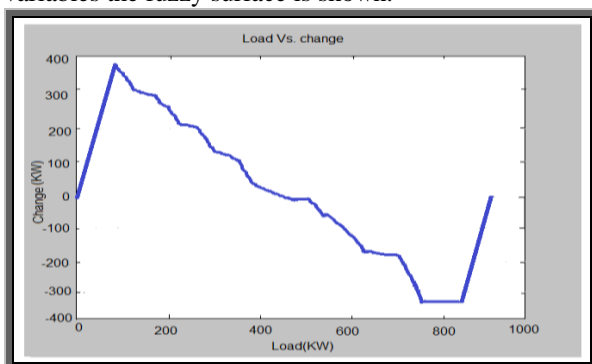Step 4 Depending upon the input and output variables the fuzzy surface is shown.

Figure 5 Fuzzy surface viewer

IV. RESULT

The different changes in load required is shown against a load value.For every load condition i.e. very less load,medium over load etc.the changes are different according to the given rule in FIS Rule Editor.MATLAB fuzzy tool box [53] is used for getting the results. We take the example of input load of [700 420 160] kW for the three phase,and balance it using fuzzy logic.The graphs showing the input load and corresponding output change is as follows:
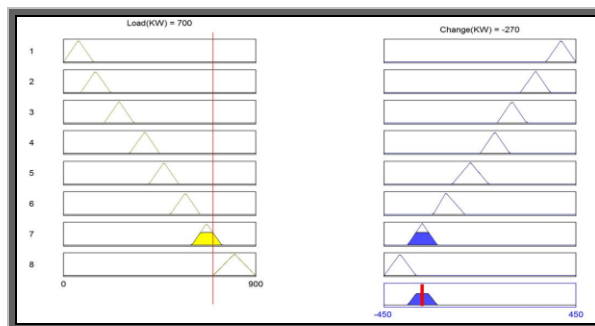

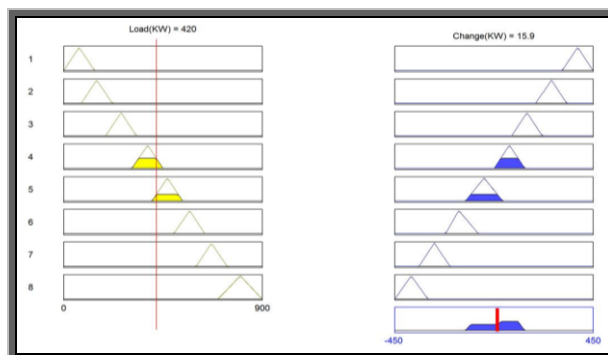**Figure 6** (the input load is 700kW,the output change corresponds to this is -270Kw

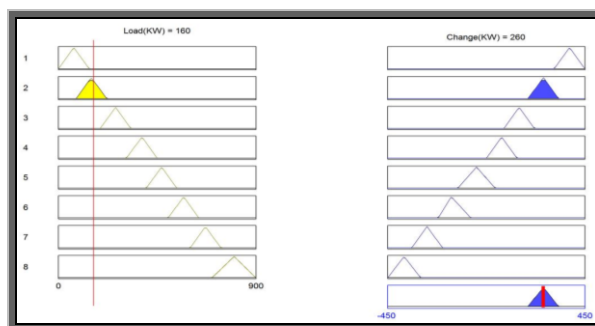**Figure 7** (the input load is 420kW, the output change corresponds to this is 16kW)

Figure 8 (the input load is 160kW, the output change corresponds to this is 260kW).

If we take it like a matrix form of 3×1, we see that input load in kW

$$P_{in} = \begin{pmatrix} 700 \\ 420 \\ 160 \end{pmatrix}$$

And the load change in kW is

$$P_{fuzzy} = \begin{pmatrix} -270 \\ 16 \\ 260 \end{pmatrix}.$$

Since we assume that the total change i.e. sum of plus sign load and minus sign load are not equal with each other, i.e.

$\triangle$

$\sum$ P fuzzy =Pin P fuzzy   Equation 1
$$= +6 \neq 0 \text{ kW}$$

Now, implementing this change in load causes a is addition of +6 kW of overall load. It is not manageable because we can only change the load position among the total 3 Phase by safeguarding the overall load without enhancing and decline the overall load.

Looking towards this we need to implement Error Correction – The equation 2, 3, 4 & 5 are taken from [5]

The average error (AE) is given as

$$AE = round\left(\frac{\Delta P_{fuzzy}}{3}\right) \quad \text{Equation 2}$$

We use the AE to make the error matrix ΔP_{error}, by distributing the AE equally in the three phases.

$$\Delta P_{error} = \begin{bmatrix} AE \\ AE \\ \sum \Delta P_{fuzzy} - 2*AE \end{bmatrix} \quad \text{Equation 3}$$

$$= \begin{pmatrix} 2 \\ 2 \\ 4 \end{pmatrix} \quad \text{Equation 5.2}$$

So final load change configuration ΔP, by subtracting the ΔP_{error} from the uncorrected fuzzy output ΔP_{fuzzy}

$$\Delta P = \Delta P_{fuzzy} - \Delta P_{error} \quad \text{Equation 4}$$

$$\Delta P = \begin{pmatrix} -270 \\ 16 \\ 260 \end{pmatrix} - \begin{pmatrix} 2 \\ 2 \\ 4 \end{pmatrix} \text{ kW}$$

$$= \begin{pmatrix} -272 \\ 14 \\ 256 \end{pmatrix} \text{ kW}$$

$$P_{final} = P_{in} + \triangle P \quad \text{Equation 5}$$

$$= \begin{bmatrix} 700 \\ 420 \\ 160 \end{bmatrix} + \begin{bmatrix} -272 \\ 14 \\ 256 \end{bmatrix} = \begin{bmatrix} 428 \\ 434 \\ 416 \end{bmatrix} \text{ kW}$$

Using equation (4) on Pin and P_{final} we get, Initial Absolute Average Unbalance (IAUB) / Phase = 360 kW
Final Absolute Average Unbalance (FAUB) / Phase = 8 kW
The curtailment of imbalance shows betterment of the balancing load.

V. CONCLUSION

Load balancing is done to make the system reliable and also to enhance the system security. With the aid of load balancing the distribution feeder loses are also reduced. The protective device of the distribution networks should effectively worked in a coordinate manner the switches should be there for protection and co

nfiguration management. Normally, two kinds of switches i.e. Sectionalizing switches (normally closed switches) and the switches (normally open switches) whenever the load demand of a section is increases or decrease the fuzzy load balancing techniques gives the appropriate amount of load change required to balance the phase, this change in load can be positive or negative depending upon the load is lesser or higher.

This change is load is implemented with the help of switches whose status is changed from one point of feeder to the other. During this period the distribution network is rearranged to achieve system security and reliability. Here, three phase, unbalance feeder is used to test the balancing of load in our system. This technique is affirmed by implementing it using fuzzy logic tool box of MATLAB which shows its effectiveness reducing the feeder unbalance condition.

REFERENCES

[1]. HTTP://WWW.EECS.QMUL.AC.UK/~MMH/AINOTES/AINOTES1.PDF
[2]. J.B.Gupta *"A course in power systems"* S.K.Kataria& Sons publishers of engineering and computer books.
[3]. Yogesh Gorane, Dr. Nisha Sarwade, Vishal Vaswani *"Testing system for control panel of switchgear Using MATLAB and PIC"* International journal of scientific engineering and technology (ISSN: 2277-1581), Volume No.1, Issue No.2 pg: 41-45 01 April 2012.
[4]. Mugdegem Tanrioven and Kayhan Gulez *"The determination and realization of compensation degrees in power control systems having load asymmetry by using fuzzy logic controller supported by artificial neural networks"* Published in:Electro technical Conference, (Volume: 1) Page(s): 590 - 594 vol.1, ISBN: 0-7803-3879-0 Publisher: IEEE, May 1998.
[5]. Abhisek Ukil *"Intelligent Systems and signal Processing In Power Engineering" 2007*, Springer.