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RESEARCH ARTICLE

AN INTELLIGENT LOAD SHEDDING TO IMPROVE POWER SYSTEM CONGESTION

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ABSTRACT

In our present day to day life, power demand is the major problem of talking. The major causes for power demand is increasing no of utilities or lack of generation source. At any critical situation we will shed down excess of load in order to retrieve the power system stability. Shedding excessive load will affect other areas. In order to prevent that an optimum amount of load shed is needed. It is obtained by using fuzzy expert system as a tool. This has shown some improvement compared to conventional load shedding procedure.

INTRODUCTION

During emergency conditions, one of the main operator's tasks is to keep as many customers on-line as possible. The rise in demand is very steep for the reasons of rise in electrical utility appliances which is now the order of the day. So the developing countries where there is free market cannot ration the usage of electrical appliances. This has steeply increased the demand. The "intelligent load shedding" is a means enabling to improve power system stability, by providing a real time adapted load control and load shedding, in situations where the power system otherwise would go unstable. The main aspects are evaluating the right amount and location of power response for a given disturbance and evaluating the right time response expected in order to comply with the acceptable stability recover. Congestion can be viewed as if the power exchanges were not controlled. Some lines located on particular paths may become overload and this phenomenon is called congestion. Congestion management can be defined as the quick operations taken by the technical persons to relieve the problem. One such approach is intelligent load shedding. If excessive load shedding in the system is done, there will be sudden change in the system voltage profile that causes transients in the system.

Fundamentals of Load shedding

The data's from the substation are taken and with these data's an idea for optimum load shedding is arrived using fuzzy expert system. The below are the conventional load shedding methodologies followed by the utility providers.

Breaker interlock load shedding

This is the simplest method of carrying out load shedding. For this scheme, the circuit breaker interdependencies are arranged to operate based on hard wired trip signals from an intertie circuit breaker or a generator trip. This method is often used when the speed of the load shedding is critical. Eventhough its execution is fast it has no of inherent drawbacks.

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Under frequency relay load shedding

Guidelines for setting up a frequency load shedding are common to both large and small systems. Upon reaching the frequency set point and expiration of pre-specified time delay, the frequency relay trips one or more load breakers. This cycle is repeated until the system frequency is recovered. e.g., 10% load reduction for every 0.5% frequency reduction. Since this method of load shedding can be totally independent of the system dynamics, total loss of the system is an assumed possibility.

Programmable logic controller based load shedding

With a programmable logic controller scheme, load shedding is initiated based on the total load versus the number of generators online or detection of under-frequency conditions. Each substation PLC is programmed to initiate a trip signal to the appropriate feeder breakers to shed a preset sequence of loads. This static sequence is continued until the frequency returns to a normal, stable level.

PROPOSED METHODOLOGY

Till now there is no standard load shedding methods implemented in indian power grid operations. Decision for load shedding will taken using conventional power flow calculations at centralized load centres and it will be communicated to local or sub load centres where it will be implemented. This procedure is followed in TNEB. The load shedding scheme mainly has included the measurements of important parameters for estimating the magnitude of disturbance. The initial estimation of the disturbance is based on the rate of change of frequency. The location of load to be shed and the amount to be shed from each bus is calculated by the empirical formula.

Fuzzy logic approach

An introduction to fuzzy:

- Fuzzy logic is a type of artificial intelligence.
- It is a problem solving control system methodology systems.
- It can be implemented in hardware, software or a combination of both.

- It reduces the design development cycle.

What is fuzzy?

In fuel station if you stop a fuel injecting motor at 1.55897 litres, it can be done with the help of fuzzy logic. Fuzzy has a meaning like accurate. The amount of load to be shed in each step is an important factor for the efficiency of the scheme. By reducing the loads in each step the possibility of over shedding is reduced. The amount of load steps is, at times, large which causes excessive load to be shed. Most schemes do not have the flexibility to increase the number of load shedding steps, there by introducing transients in the system. In fuzzy expert system the important paramerters which are responsible for load shedding are used to make membership function from which optimum load shedding is achieved.

Procedures for Load shedding

Here are some general procedures followed for load shedding is given.

- The data's which are responsible for system transients are collected firstly. For our consideration, the data's from pazhayasivaram substation is collected and used for load shedding.
- The ranges of voltage, frequency, power is taken here.
- After the data's are collected it is converted to per unit basis, if it not so.
- Create a table and enter the values of voltage, frequency, power.
- The value of reactive power is considered here.
- Now change in voltage and frequency with respect to time is calculated for calculation purpose.
- The amount of load shedding is calculated by using the formula,

$$S= ((dv/dq) / (\sum dv/dq))\, pdiff.$$

Where,
S= load to be shed.
dv = change in voltage w.r.t time.
dq = change in power w.r.t time.
Pdiff= power difference.

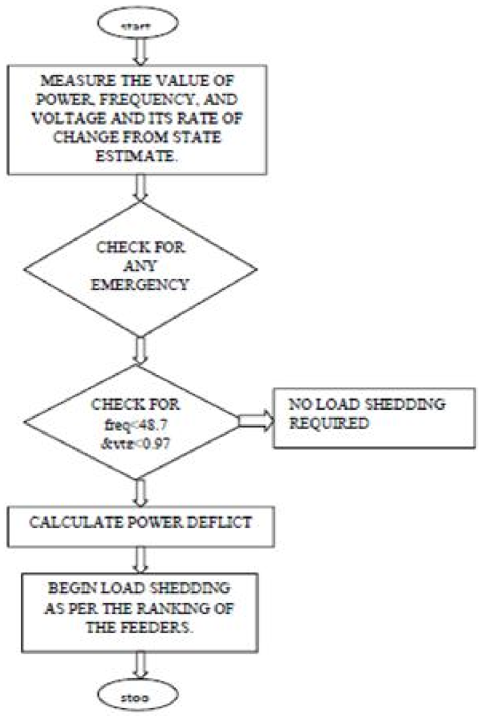
To calculate the pdiff value,

$$Pdiff= (2H/fo)\,(df/dt).$$

Where,
H= inertia constant (5sec).
fo= nominal frequency

- After calculation the amount of load to be shed is known. Now a new column in which load to be shed and in another the pdiff values are entered.
- From the table the minimum and maximum ranges of values of each variable is calculated to create the membership function.
- Now membership function is created for voltage, frequency, pdiff, reactive power by dividing the ranges into 3 categories, for simple calculation.
- Membership function for this consideration is LOW, MEDIUM, HIGH.
- Find the corresponding values in table.
- Create rules based on membership function. (if-then rule)
- Create a fuzzy linguistic control table.
- Apply the values in fuzzy MATLAB software and create the rules from the table.
- It must be noted that the rules which we create must satisfy all the values with in the given range.
- For our given value the amount of load shed is displayed.
- Now if we compare the output with the conventional methods of load shedding it will be minimum only.

Flowchart for load shedding



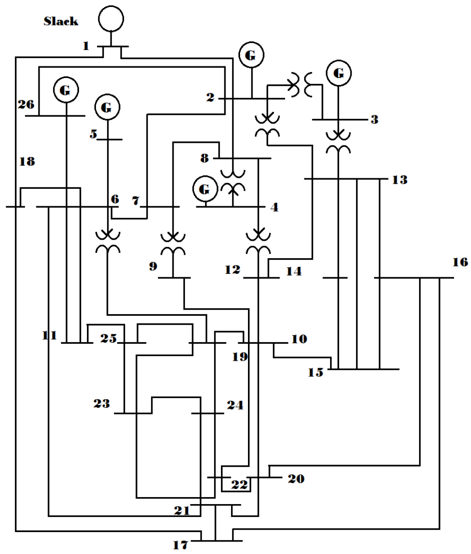


Figure 1. Circuit diagram for 26-bus system

Membership function creation

Let each variable and the load shedding amount, s, be distinguished by three linguistic terms: LOW (L), MEDIUM (M), HIGH (H). After analysis and from observation, the following linguistic rules describing the load-shedding amount at substation can be formed. The membership function is created by considering the min and max ranges of the variables and dividing each into 3 equal values and classifying each by the name low, medium, high as we mentioned earlierly.

Table 1. load data's

S.No.	Voltage	Reactive power	Frequency
1	1.025	0.41	48.7
2	1.020	0.15	48.5
3	1.035	0.5	49.5
4	1.050	0.1	49.2
5	1.045	0.3	49.7
6	0.999	0.29	48.5
7	0.994	0	50
8	0.997	0	50
9	1.009	0.5	49.5
10	0.989	0	50
11	0.997	0.15	48.5
12	0.993	0.48	48.7
13	1.014	0.15	48.5
14	1.000	0.12	48.5
15	0.991	0.31	48.6
16	0.983	0.27	48.5
17	0.987	0.38	48.7
18	1.007	0.67	48.7
19	1.004	0.15	48.5
20	0.980	0.27	48.7
21	0.977	0.23	48.7
22	0.978	0.22	48.7
23	0.976	0.12	49.3
24	0.968	0.27	48.7
25	0.974	0.13	49.4
26	1.015	0.2	49.8

Table 2.

S.No	dv/dt	dq/dt	df/dt
1	0.025	0.59	1.3
2	0.02	0.85	1.5
3	0.035	0.5	0.5
4	0.05	0.9	0.8
5	0.045	0.7	0.3
6	0.001	0.71	1.5
7	0.006	1	0
8	0.003	1	0
9	0.009	0.5	0.5
10	0.011	1	0
11	0.003	0.85	1.5
12	0.007	0.52	1.3
13	0.014	0.85	1.5
14	0	0.88	1.5
15	0.009	0.69	1.4
16	0.017	0.73	1.5
17	0.013	0.62	1.3
18	0.007	0.33	1.3
19	0.004	0.85	1.5
20	0.020	0.73	1.3
21	0.023	0.77	1.3
22	0.022	0.78	1.3
23	0.024	0.88	0.7
24	0.032	0.73	1.3
25	0.026	0.87	0.6
26	0.015	0.8	0.2
	∑dv/dt=0.441	∑dq/dt =19.63	

The range of voltage value is selected and the membership function is created within that range by dividing the difference value of max and min value by 3. Now the value is added with the least (min) value to find the first membership function. With the first membership value the divided value is again added to form the second membership function and so on. The same procedure is followed for all the variables to form membership function.

INPUT VOLTAGE (L1)

0.968-1.05→ range
0.968-0.981-0.995→ LOW (MF1)
0.995-1.008-1.022→ MEDIUM (MF2)
1.022-1.036-1.05→ HIGH (MF3)

Table 3.

S.No	Pdiff	Load to be shed
1	0.26	0.49
2	0.31	0.32
3	0.1	0.31
4	0.16	0.39
5	0.06	0.17
6	0.31	0.02
7	0	0
8	0	0
9	0.1	0.08
10	0	0
11	0.31	0.04
12	0.26	0.15
13	0.31	0.23
14	0.31	0
15	0.28	0.16
16	0.31	0.32
17	0.26	0.24
18	0.26	0.24
19	0.31	0.06
20	0.35	0.42
21	0.33	0.44
22	0.37	0.46
23	0.35	0.42
24	0.35	0.68
25	0.33	0.44
26	0.04	0.03

REACTIVE POWER (L2)

0-0.5→ range
0-0.083-0.166→ LOW (MF1)
0.166-0.249-0.33→MEDIUM (MF2)
0.33-0.413-0.5→ HIGH (MF3)

FREQUENCY (L3)

48.7-50→ range
48.7-48.915-49.13→ LOW (MF1)
49.13-49.34-49.56→ MEDIUM (MF2)
49.56-49.78-50→ HIGH (MF3)

POWER DIFFERENCE (L4)

0-0.37→ range
0-0.06-0.12→ LOW (MF1)
0.12-0.18-0.24→ MEDIUM (MF2)
0.24-0.3-0.37→ HIGH (MF3)

LOAD TO BE SHED: (OUTPUT)

0-0.68→ range
0-0.12-0.23→ LOW (MF1)
0.23-0.35-0.46→ MEDIUM (MF2)
0.46-0.57-0.68→ HIGH (MF3)

Fuzzy Linguistic control Table

Input1 voltage	Input2 r.power	Input3 freq	Input4 pdiff	output load shed
medium	medium	high	low	low
low	medium	high	low	low
high	high	medium	low	medium
high	low	medium	medium	medium
low	medium	low	high	high

Table 4. Generation data's

S.No	Voltage	r.power	frequency
1	1.025	2.24	48.7
2	1.020	1.25	48.5
3	1.035	0.63	49.3
4	1.050	0.49	49.5
5	1.045	1.24	48.5
6	1.015	0.33	49.7

Table 5.

S.No	dv/dt	dq/dt
1	0.025	1.24
2	0.020	0.25
3	0.035	0.37
4	0.050	0.51
5	0.045	0.24
6	0.015	0.33

Table 6.

Sl.no	Pdiff	Load to be shed
1	0.27	0.08
2	0.31	0.38
3	0.14	0.20
4	0.1	0.15
5	0.31	0.89
6	0.06	0.04

Membership function creation

The procedures to create membership function for load data's is same as followed here.

INPUT VOLTAGE (L1)

1.015-1.05→ range
1.015-1.021-1.027→low (mf1)
1.027-1.033-1.039→medium (mf2)
1.039-1.045-1.05→high (mf3)

REACTIVE POWER (L2)

0.33-2.24- range
0.33-0.65-0.97→low (mf1)
0.97-1.29-1.61→medium (mf2)
1.61-1.93-2.24→high (mf3)

FREQUENCY (L3)

48.5-49.7 →range
48.5-48.7-48.9→ low (mf1)
48.9-49.1-49.3→ medium (mf2)
49.3-49.5-49.7→ high (mf3)

POWER DIFFERENCE (L4)

0.06-0.31→ range
0.06-0.1-0.14→ low (mf1)
0.14-0.18-0.22→medium (mf2)
0.22-0.26-0.31→ high (mf3)

LOAD TO BE SHED: (OUTPUT)

0.04-0.89→ range
0.04-0.18-0.32→ low (mf1)
0.32-0.46-0.6→ medium (mf2)
0.6-0.74-0.89→ high (mf3)

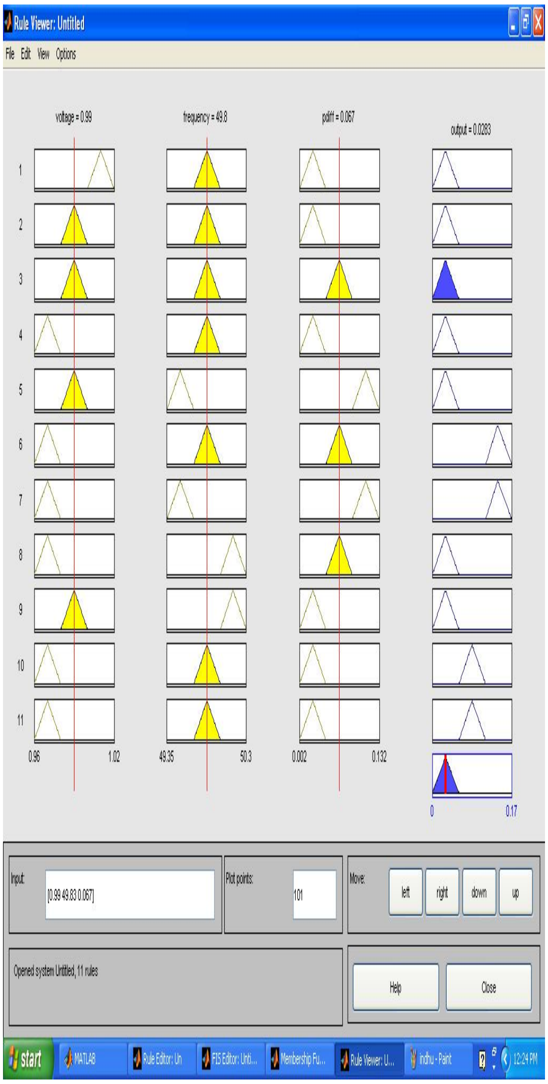
Fuzzy Linguistic control Table

Input1 voltage	Input2 frequency	Input3 pdiff	Output load to be shed
low	low	low	low
low	low	high	medium
medium	medium	medium	low
high	high	medium	low
high	low	high	high
low	high	low	low

Table 7. Transformer Data

Transformer Designation	Tap Setting Per Unit
2-3	0.960
2-13	0.960
3-13	1.017
4-8	1.050
4-12	1.050
6-19	0.950
7-9	0.950

Simulation result



Comparative Results between Conventional Method and FUZZY system Approach

S.No	Voltage	Frequency	Load to be shed (Conventional)	load to be shed (Fuzzified)
1.	1.025	48.7	0.49	0.4
2.	0.983	48.5	0.32	0.2
3.	0.978	48.7	0.46	0.3
4.	1.014	48.5	0.23	0.02
5.	0.968	48.7	0.68	0.4

Conclusion

From the comparison it is clear that fuzzy scaling of critical parameters and writing the fuzzy linguistic rules properly, has clearly given food results. The amount of load to be shed is minimized. This method has been developed from the data's obtained from the substation and the discussions with the field engineers. It is a logical thought by some ways and means the load shedding has to be minimized. Even though load shedding is the last resort and practically followed method to relieve congestion, there is a constant urge both from field engineers and academic circle to analyze and find some ways to minimize the load shedding. In that regard this work can be respected. By building robust electronics in such a Way that the fuzzy outputs are tuned to an fuzzy controller which is again governed by another control device with feedback system and data acquisition system to monitor the bus parameters, when this forms a robust loop, this idea can be tested and if the results are satisfactory this can be implemented in distribution substations.

REFERENCES

"Microsoft StreamInsight." [Online]. Available: http://msdn. microsoftcom/en-us/library/ee362541.aspx

Ross, T. J., "Fuzzy Logic with Engineering Applications", second edition, John Wiley and Sons, Ltd, West Sussex, England, 2004.

Thompson J. G., and B. Fox, "Adaptive Ioad shedding for isolated power sfiem.3," *1EEProc.- Gener. T r a m. Distrib.*, VoI. 141, No. *5*, pp. 491- 496, Sep 1994.

Vladimir V. Terzija," Adaptive Under- frequency Load Shedding Based on the Magnitude of the Disturbance Estimation", IEEE TRANS. ON POWER SYS., VOL. 21, NO. 3, AUG. 2006.

Yong Zheng and N. Chowdhury, "Expansion of Transmission systems in a deregulated environment", *IEEE Canadian Conference on Electrical and Computer Engineering*, Vol.4, May 2-5, 2004, pp.1943-1947.

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