Case Study On Fuzzy Logic Based Network Contingency Ranking

[1]Mr. Ramesh. E , [2]Dr. R. Prakash , [3]Ms. Lekshmi. M, [4]Mr.Yogeesh. S

[1]Student , [2]Professor , [3]Asso. Professor Dept of EEE Acharya Institute of Technology, Bangalore

[4] Sr.lecturer Dept of EEE, HMSIT, Tumkur

Abstract:

Security assessment of a power system is very important function to detect any violation in the system and to ensure secure operation of the system in deregulated environment. Contingency ranking is the process of indexing the possible contingencies of the system on the basis of their severity. The method proposed in this research work takes the consideration of both apparent power overloading and voltage violations at the same time. From which Performance Indices (PI) is obtained. Masking effect is a very important factor which results in misclassification of contingencies which can be eliminated by using fuzzy logic. The proposed approach, in addition to real power loadings and bus voltage violations, voltage stability indices at the load buses are also used as the post-contingent quantities to evaluate the network contingency ranking of a Practical IEEE-30 bus system.

Key words: *Fuzzy logic, Contingency Analysis, Masking Effect, power system stability*

I.INTRODUCTION:

The main objective of an electric power system is to supply high quality energy where the interruption and interruption duration are minimized. Steady state security analysis is therefore one of the most important task of the power system planning and operation studies. The ability to maintain voltage stability has become a growing concern in operating the present day stressed power system. The monitoring and analysis of power system security has become an integral part of modern energy management systems. For secure operation of power system, the operating personnel must know which system disturbances or contingencies may cause limit violations and force the system to enter into the emergency state.

The process of investigating whether the system is secure or not [1] in a set of proposed contingencies is called contingency analysis or the Effect of the line outage when the rest of the system is stable is called contingency study. The study of contingency is an essential activity in planning operation and control of power systems. The outage or change in the independent parameters of the Power systems gives rises to transient phenomena in the electrical and electromechanical states of those power systems. Large power systems require the analysis of all the credible [2],[3] contingence within a very short time so as to exercise the control in the short time available for corrective action. Ranking methods use a performance index (PI) as scalar function to describe the effects of an outage on the whole network. Ranking methods can be divided in to two sub groups depending on the way in which the performance index is formulated by direct methods and indirect methods. For line flows or MW [4] ranking direct methods are used and they give good results. Those methods are many time faster than indirect schemes.

In recent years, intelligent system [5],[6],[7]&[8] applications have received increasing attentions in various areas of power systems such as operation, planning, control, and management. The several PIs are the choices of the weighing factors or for all critical contingencies to achieve accurate ranking.

This proposed work presents a new approach using fuzzy logic to evaluate the degree of severity [15] of the considered contingency and to eliminate masking effect in the technique. The proposed approach, in addition to real power loadings and bus voltage violations, voltage stability indices at the load buses are also used as the post-contingent quantities to evaluate the network contingency ranking of a Indian Utility System

II.CONTINGENCY ASSESSMENT

The following step by step algorithm is used for obtaining the performance indices values:

1. For the given system, considering a line outage at a time, load flow study is performed to determine bus voltage profiles.
2. L index is computed using (1) and is used as post contingent quantity.
3. Assuming trapezoidal membership function, the bus voltage profiles and L index are represented in fuzzy set notation.
4. Severity index of L index and bus voltage profiles are also represented in fuzzy set notation.

5. Using Fuzzy-If-Then rules overall severity index for bus voltage profiles and L index is determined. The Fuzzy Inference System is tested in MATLAB 9 Fuzzy Toolbox.
6. Composite index is found using the formula CI = $SI_L + \Sigma SI_{VP}$
7. The above procedure is repeated for all the line outages and the contingencies are ranked based on composite index.

III.REDUCTION OF MASKING EFFECT

The problem with all contingency selection and ranking algorithm is the misclassification and disordering of the contingencies. The PI is used up to first order formulation only for the sake of less computation or due to insufficient formulation of PI's hence it lead to misclassification. Due to masking affect the contingencies ranking of the actual state of system contingencies. By using higher exponents eliminate the masking problem. Hence in order to eliminate the masking effect high value of PIs is taken in to account. The fuzzy logic is used to reduce the masking effect by combining the several PIs for different values to make correct judgement actual state of the system.

IV.FUZZY LOGIC AND FUZZY BASED FORMULATION

The idea of fuzzy sets is an extension of conventional set theory formalised by L.A.Zadeh in 1965 in order to deal with uncertainty .The mathematical formulations of real world problems are derived under certain restrictive assumptions. Because of power systems are large , complex, geographically widely distributed system and deregulated of power utilities has introduced new issues into the existing problems. These facts make it difficult to effectively deal with many problems through strict mathematical formulations alone. Fuzzy logic is the possible answer to a number of challenging problems. The number of papers strengthen the application of fuzzy in to the power system applications due to following advantages

1. It uses linguistic variables with its value is stable.
2. Fuzzy variables value may be described not by a number but by an adjective.

Application of fuzzy logic to PI_V to eliminate masking

A. Choosing the input

Here three inputs are given to the fuzzy logic namely PI_V (m=1), PI_V (m=2) and PI_V (m=3) for the ranking of voltage index and the output is the severity index of the line

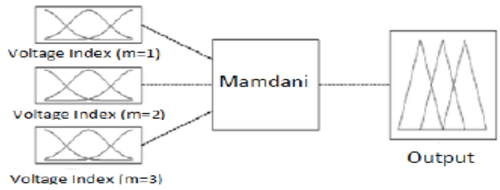

Fig.1Input and output to the fuzzy tool box

B. Shape of the membership functions.

The selection of number and shape of the membership function plays an important role in the ranking process. In the case Gaussian type membership functions is used for both input and output. Output is in the scale of [0-50]. Three Gaussian membership functions are used for the ranking of voltage index obtained from power analysis in descending order of value namely:

1. Bus voltage profiles

Low voltage: effect of the contingency doesn't have much impact on the system (below 0.95 p.u.)

Normal voltage: the effect of contingency may or may not have effect over the system (0.95 to 1.05 p.u.)

Over voltage: the effect of contingency will cause the voltage instability (above 1.05 p.u.)

2. L- index profiles

Very small : 0.18

Small : 0.62 to 0.76

Medium : 0.42 to 0.56

High : 0.62 to 0.76

Very high : 0.82 to 1.0

3. Fuzzy rule :

A fuzzy control rule is a fuzzy conditional statement in which the antecedent is a condition and the consequent is a control action. In this paper Mamdani control is used. Rules are framed for all possible combination of the membership function. Since there are three inputs PI_V(m=1), PI_V(m=2) and PI_V(m=3) three member ship functions are framed in fuzzy tool box.

The syntax used here is:

If PI_V(m=1) is X_1 And PI_V(m=2), is X_2 AND PI_V(m=3),is X_3 THEN severity is Y.

The severity index value for voltage (SI_V) for each line outage is obtained through substituting the value of $PI_V(m=1)$, $PI_V(m=2)$, and $PI_V(m=3)$, for that line in the rule viewer of the fuzzy tool box.

Table 1. Fuzzy rules

Post contingent quantity	Severity index
L index : VS S M H VH	VLS LS BS AS MS
Voltage : VL NV OV	MS BS AS

Note: VLS- very less severe; LS- less severe; BS- below severe; AS – above severe; MS – more severe.

V. TEST RESULTS

The proposed approach is tested under simulated condition on IEEE-30 bus system. A.C load flow is carried out to select the heavily loaded lines based on Voltage Collapse Proximity Indicator. The IEEE-30 bus system consists of 6 generators, 2 shunt capacitors and 41 transmission lines. Contingency screening is carried out to identify all the heavily loaded lines. On contingency screening total 41 transmission line outages are considered for ranking. To eliminate the masking different loading conditions are carried. The following Table shows the 100% and 120% load. Fuzzy approach effectively ranks contingencies under different load conditions.

Table 1: Contingency Ranking Based on L index using Fuzzy Approach: 100% load

Rank	Line outages	SIV(SUM)	SIL	CI
26	1-2	5128.61	14.59	5143.21
29	1-3	5082.47	14.83	5097.31
8	2-4	5858.57	14.75	5873.32
7	3-4	5861.57	14.66	5876.23
4	2-5	5910.00	16.29	5926.29
5	2-6	5881.00	14.75	5895.75
1	4-6	6058.19	25.44	6083.63
3	5-7	5988.28	14.85	6003.13
2	6-7	6033.00	15.01	6048.01
38	6-8	4286.80	9.035	4295.84
10	6-9	5526.42	14.45	5540.88
39	6-10	4218.42	9.03	4227.46
24	9-11	5133.80	12.19	5146.00
25	9-10	5132.52	12.21	5144.73
41	4-12	2776.72	7.49	2784.22
40	12-13	3654.57	8.18	3662.75
14	12-14	5156.66	12.59	5169.25
13	12-15	5158.66	12.47	5171.14
33	12-16	5024.33	12.04	5036.37
16	14-15	5152.19	12.87	5165.06
34	16-17	5022.76	12.27	5035.03
37	15-18	4401.09	12.57	4413.66
21	18-19	5146.42	12.66	5159.06
20	19-20	5148.66	12.28	5160.95
19	10-20	5151.23	12.64	5163.88
35	10-17	5018.76	12.48	5031.25
27	10-21	5128.1	12.28	5140.47
18	10-22	5151.38	12.61	5163.99
22	21-22	5144.90	12.57	5157.47
15	15-23	5155.66	12.56	5168.23
31	22-24	5055.85	12.16	5068.02
17	23-24	5151.57	12.68	5164.25
28	24-25	5092.28	12.55	5104.84
23	25-26	5139.71	12.56	5152.27
11	25-27	5229.85	12.52	5242.37
36	28-27	4993.90	12.64	5006.55
32	27-29	5034.38	12.70	5047.08
30	27-30	5066.95	12.64	5079.59
12	29-30	5164.76	12.72	5177.48
6	8-28	5870.28	12.66	5882.95
9	6-28	5782.00	14.68	5796.68

Table 2: Contingency Ranking Based on L index using Fuzzy Approach : 120% load

Rank	Line outages	SIV(SUM)	SIL	CI
28	1-2	5279.38	12.79	5292.17
29	1-3	5264.38	15.3	5279.68
8	2-4	6025.09	17.98	6043.08
7	3-4	6028.04	18.19	6046.24
3	2-5	6075.8	18.57	6094.38
5	2-6	6050.33	18.41	6068.75
1	4-6	6869.28	18.31	6887.59
2	5-7	6157.09	18.31	6175.4
4	6-7	6060.52	18.62	6079.14
38	6-8	4661.29	15.35	4676.65
12	6-9	5673.95	17.82	5691.78
39	6-10	4400.15	11.02	4411.18
24	9-11	5289.95	15.6	5305.55
27	9-10	5278.47	15.49	5293.97
41	4-12	3356.65	9.39	3366.05
40	12-13	3779.71	10.1	3789.81
16	12-14	5299.14	15.51	5314.65
14	12-15	5308.23	15.67	5323.9
34	12-16	5162.61	15.23	5177.85
17	14-15	5297.52	15.62	5313.14
33	16-17	5163.61	15.38	5179
37	15-18	4846.19	15.04	4861.23
23	18-19	5290.57	15.63	5306.2
22	19-20	5292.85	15.66	5308.51
19	10-20	5296.23	15.5	5311.73
35	10-17	5160.76	15.57	5176.33
26	10-21	5283.33	15.1	5298.43
20	10-22	5295.71	15.55	5311.26
25	21-22	5289.95	15.5	5305.45
11	15-23	5938.47	18.39	5956.86
15	22-24	5303.33	15.58	5318.91
18	23-24	5296.57	15.65	5312.22
31	24-25	5236.47	15.48	5251.95
21	25-26	5294.04	15.39	5309.43
10	25-27	6011.04	18.28	6029.33
36	28-27	5115.33	14.87	5130.2
32	27-29	5182.71	15.51	5198.22
30	27-30	5241.57	15.42	5256.99
13	29-30	5311.76	15.7	5327.46
6	8-28	6043.71	17.95	6061.66
9	6-28	6024.28	18.38	6042.66

Table 3: Comparison of Contingency Ranking using Fuzzy Approach based on L index and MSV

Line outages	100% load		120% load	
	L Index	MSV	L Index	MSV
1-2	26	26	28	28
1-3	29	29	29	29
2-4	8	8	8	8
3-4	7	7	7	7
2-5	4	4	3	3
2-6	5	5	5	5
4-6	1	1	1	1
5-7	3	3	2	2
6-7	2	2	4	4
6-8	38	38	38	38
6-9	10	10	12	12
6-10	39	39	39	39
9-11	24	24	24	24
9-10	25	25	27	27
4-12	41	41	41	41
12-13	40	40	40	40
12-14	14	14	16	16
12-15	13	13	14	14
12-16	33	33	34	34
14-15	16	16	17	17
16-17	34	34	33	33
15-18	37	37	37	37
18-19	21	21	23	23
19-20	20	20	22	22
10-20	19	19	19	19
10-17	35	35	35	35
10-21	27	27	26	26
10-22	18	18	20	20
21-22	22	22	25	25

15-23	15	15	11	11
22-24	31	31	15	15
23-24	17	17	18	18
24-25	28	28	31	31
25-26	23	23	21	21
25-27	11	11	10	10
28-27	36	36	36	36
27-29	32	32	32	32
27-30	30	30	30	30
29-30	12	12	13	13
8-28	6	6	6	6
6-28	9	9	9	9

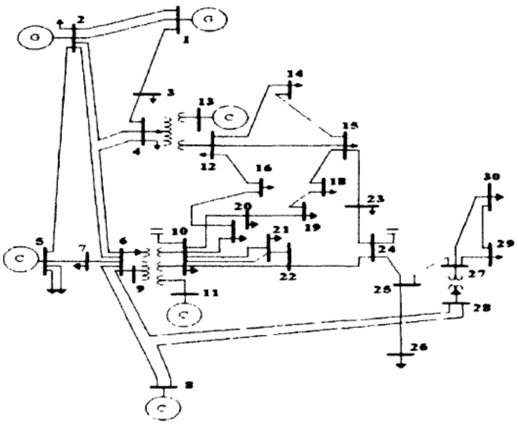

Fig.2 IEEE 30 Bus System

VI. CONCLUSION

Fuzzy approach is used for combining the effect of L index with bus voltage profiles for ranking the contingencies. Fuzzy approach effectively ranks contingencies under different load conditions. The Fuzzy approach is flexible in incorporating human experience and heuristics. It includes the imprecision of linguistic terms associated with voltages and L index translates them into numerical values, which offers more flexibility, better insight into reality than conventional methods. Through proper tuning of membership functions in fuzzy representation, the approach can mimic experienced operators' performance in conducting contingency ranking.

REFRENCES

[1] Anant Oonsivilai and Kenedy A. GreysonWorld "Power System Contingency Analysis Using Multiagent Systems", Academy of Science, Engineering and Technology ,pp355-360,Vol 60, 2009

[2]D.Thukaram,L.Jenkinsand K.Visakha"Improvement of system security with unified power flow controller at suitable locations under network contingencies of inter connected systems.IEE proc-Gener.Trans.Distrib vol 152,No.5,sep 2005.

[3] Q. Chen and J. McCalley, "Identifying high risk N ¡ k contingencies for online security assessment," IEEE Transactions on Power Systems, vol. 20, no. 2, pp. 823–834, May 2005.

[4] Aydogan ozdemir and chanan singh "Fuzzy logic based MW contingency ranking against masking problem"0-7803-6672-7/01/2001 IEEE

[5] K.L.LO & A.K.I Abdelaal"Fuzzy logic based contingency analysis". International conference on electric utility deregulation and restructuring and power technology 2000

6] T.S.N.R .K srinivas,K.Ramesh Reddy ,V.K.D.devi "Composite criteria based Network contingency ranking using fuzzy logic approach.2009, IEEE international Advance computing conference(IACC-2009)

[7] R.C. Bansal Biblography on the Fuzzy set theory application in power system(1994-2001) IEEE transaction on power systems Vol-18 No.4 Nov 2003

[8] D.Murali,Dr.M.Rajaram,N.Reka "Comparison of FACTS Devices for Power System Stability Enhancement " International paper of computer applicationsVol8-No.4 Oct 2010.

[9] Ibrahim Mansour,Djaffar ould Abdeslam,Patrice Wira,Jean Merckle "Fuzzy logic control of a SVC to improve the transient stability of ac power systems" 978-1-4244-4649-0/09© 2009 IEEE.

[10] K L.LO & Laiq khan"Fuzzy Logic Based SVC For Power System Transient Stability K Enhancement"0-7803-5902-X/00/© 2000 IEEE.

[11]Bansilal,D.Thukaram,K.Harish Kashyap"Artificial Neural Network Application to Power System Voltage Stability Improvement" 0-7803-7651-X/03 /© 2003 IEEE

[12]PrzemyslawJanic,Zbigniew Leonowicz,Tadeusz Lobos,Zbigniew Waclawek"Analysis of Influence Of Power Quality Distrubances Using A Neuro-Fuzzy System"

[13] M.A.Abido &Y.L.Abdel-Magid"A Hybrid Neuro-Fuzzy power System Stabilizer for Multimachine Power systems", IEEE transaction on Power Systems, Vol.13,No.4, Nov 1998

[14] Laiq Khan,N.Ahmed and Carlos Lazano"GA Neuro-Fuzzy Damping Control system for UPFC to enhance power system transient stability" proceedings IEEE INMIC 2003.

[15] K.Pandiarajan and C.K.Babulal "Overload Alleviation in Electric Power System Using Fuzzy Logic" International Conference on Computer, Communication and Electrical Technology – ICCCET2011, 18 th & 19 th March, 2011.

[16] Zakir Hussain, Zhe Chan and Paul Thogersen " Fast and Precise Method of Contingency ranking in Modern power system" 2011 IEEE jorden conference on applied engineering and computing technologies(AEECT