ISSN: 2278 – 1323
International Journal of Advanced Research in Computer Engineering & Technology (IJARCET)
Volume 5, Issue 7, July 2016

Power System Analysis based on Dynamic Security Assessment Using Fuzzy Logic

Triveni Ambre, Priyanka More

Abstract— **Dynamic security assessment (DSA) is an standard intrigue in modern power system stability opinion. We are implementing pattern discovery (PD) based fuzzy classification scheme for the DSA. Firstly, the Pattern Discovery algorithm is improved by combining the proposed centroid deviation analysis technique and the prior knowledge of the training data set. This improvement can increase the performance and efficiency when apply it to extract the patterns of data from a training data set of power system. Next, based on the results of the improved Pattern Discovery algorithm, a fuzzy logic-based classification method is developed to check the security index of a given power system operating point. The correspondence demonstrates that the proposed model is more functioning in the dynamic security analysis of a power system**

Index Terms— **Fuzzy Control, Pattern Discovery, Dynamic Security Assessment, Data Mining Introduction.**

I. Introduction

Security of power system is important now a day. Security assessment has always been an important topic in power system operation. Operation of power system is exposed to many kinds of disturbances and faults. Depending on the seriousness of the disturbances and faults, the power system may lose its security, which can result in general consequences, such as widespread blackouts, so in order to reduce the risk and degree of failure in power system we introduce analysis of power system using fuzzy logic.

Power system security can be divided into static security and dynamic security. Static security problem can be solved by a set of algebraic equations and can be solved quickly, while the dynamic security problem is in the form of a large number of nonlinear differential algebraic equations so it is difficult to solve quickly. The security assessment of power system consists of steady state security assessment (SSA) and dynamic security assessment (DSA), SSA is the system steady state operating points between dynamic transitions and DSA is security of system dynamics in various timescales from transients of several seconds to slow down dynamics of several minutes or even hours.[1]

Manuscript received July 2016.

Triveni Ambre*, Department of Computer Engineering,Genba Sopan rao Moze College,Balewadi,, Pune,India*
Priyanka More*, Department of Computer Engineering,Genba Sopan rao Moze College, Balewadi, Pune, India.*

In DSA, many security aspects of power systems are assessed, including transmission line thermal loading, voltage, rotor angles and frequency deviation[1].The base paper referred present novel pattern discovery (PD) based fuzzy classification scheme for the DSA. Specially, the pattern discovery algorithm is improved by combining the proposed centroid deviation analysis technique and the prior knowledge of the training data set[2]. This improvement can increase the performance and efficiency when apply it to extract the patterns of data from a training data set of power system. Favour, based on the results of the improved pattern discovery algorithm, a fuzzy logic-based classification course is developed to predict the security index of a given power system operating point. So in order to prevent the wide spread blackouts of power system we introduce fuzzy logic to increase the efficiency of dynamic security.

A. *MOTIVATION*

We are facing new challenges in power industry. The power grid is experiencing more severe blackouts, which usually involve cascading outages. The large-scale blackouts are low-probability, high-consequence events because they are rare but may cause great economical loss if they occur. Based on the experience of the major blackouts around the world, DSA has been indicated as an important issue that should be considered to mitigate the low-probability, high-consequence events [4].Traditional off-line DSA tries to analyze the low-probability, high-consequence events exhaustively, but is subject to uncertainties and computing capabilities especially when cascading outages are involved. With state-of-the-art computing facilities, power engineers are seeking for new strategies to monitor and control the modern power grids online to enhance power system dynamic security and prevent large-scale blackouts. Thus, there is need to further inspect existing power system DSA functions and design a architecture that better fits into the modern power industry.

II. LITERATURE SURVEY

In this section we study some method for dynamic security assessment of Power system.

A. Application of Neural Network Based Pattern Recognition approach to security assessment of Power system

KALYANI and K. SHANTI SWARUP in [10] gave about the design of pattern recognition system using the different Neural Network Models undergoes a series of sequential steps. The main stages are as follows:
Stage 1: Data Generation (Pattern Variables)
Stage 2: Feature Selection (Feature Variables)
Stage 3: Classifier Design (Classification Function)
Stage 4:Performance Evaluation of Classifier
Steps representing a classification system or predictive model for an object

1. Preparation : Cases with classifications are separated randomly into a learning set and a test set Predictors are selected from available parameters.
2. DT growing : The learning sets are divided recursively into more maximal binary tree. At each splitting, questions about predictors are scored by purities of two child nodes Question with highest score is selected and called Critical Splitting Rule (CSR) Other questions are called competitors; questions that mimic the action of the CSR are called surrogates As the tree grows, nodes become more homogeneous.
3. DT pruning : Maximal tree is pruned step by step to generate a series of DTs with descending sizes Performance of each DT is checked on the test set.
4. Selecting the best DT Minimizing the misclassification cost

B. Fuzzy Based Sliding Mode Control

LATHA.R,KANTHALAKSHMI.S,KANAGARAJ.J[5] have discussed The Fuzzy Sliding Mode Control (FSMC) technique, is an integration of variable structure control and FLC, provides a simple way to design FLC systematically. FSMC is control method achieves asymptotic stability of the system. Another feature is that the method can minimize the set of FLC and provide robustness against model uncertainties and external disturbances.

C. Support Vector Machine

Christian Andersson [6] discussed about Support vector machine. The aim is to use support vectors for calculating a hyper plane in high dimensions. This hyper plane separates the data with the maximum distance between the classes. The separation can be both linear and nonlinear. The theory is applied to classification of power system stability. SVM [7]performs the task of classification by first mapping the input data to a multidimensional feature space and then constructing an optimal hyper plane classifier separating the two classes with maximum margin.

SVM performs minimization of error function by an iterative training algorithm to construct an optimal hyper plane. Consider a training set T = x_i, y_i, where x_i is a real valued n dimensional input vector and y_i +1,1 is a label that determines the class of data instance, x_i. The hyper plane (dotted line) is determined by an orthogonal vector (w) and a bias (b). The points closest to the optimal separating hyper plane with the largest margin are called as Support Vectors (SVs).

D. Decision Trees

N. Hatziargyriou1 J. A. Peas Lopes E. Karapidakis M. H. Vasconcelos discussed about the decision tree [8]The decision tree methodology is a non-parametric learning technique able to produce classifiers about a given problem in order to deduce information for new unobserved cases.The DT has the hierarchical form of a tree structured upside down.The construction of a DT starts at the root node with the whole LS of pre-classified OPs. These OPs are analysed in order to select the test T that splits them optimally into a number of most purified subsets. For the sake of simplicity, a two-class partition is considered. The test T is defined as: T: Ai less than t (2) where t is the optimal threshold value of the chosen attribute Ai.The selected test is applied to the LS of the node splitting it into two subsets, corresponding to the two successor nodes.

The optimal splitting rule is applied recursively to build the corresponding subtrees. In order to detect if one node is terminal, i.e. sufficiently class pure, the stop splitting rule is used, which checks whether the entropy of the node is lower than a present minimum value. If it is, the node is declared a leaf, otherwise a test T is sought to further split the node. If the node cannot be further split in statistically significant way, it is termed a deadend, carrying the two class probabilities estimated on the basis of the corresponding OPs subset.

E. Fuzzy approach for ranking the contingencies using composite-index.

Shobha Shankar, A. P. Suma, and Dr. T. Ananthapadmanabha discussed the Fuzzy approach for ranking the contingencies using composite-index[9]. The fuzzy approach uses post-contingent bus-voltage profiles and Lindex used as static voltage collapse proximity indicator to compute voltage stability margin. To evaluate contingency ranking he composite index based on severity of bus voltage profiles and L-index is used. Basically, there are four approaches to the derivation of fuzzy rules: (1) from expert experience and knowledge, (2) from the behaviour of human operators, (3) from the fuzzy model of a process, and (4) from learning. Linguistic variables allow a system to be more understandable to a non-expert operator. In this way, fuzzy logic can be used as a general methodology to incorporate knowledge, heuristics or theory into controllers and decision making.

III. PROPOSED APPROACH- FRAMEWORK AND DESIGN

A. *Problem Definition*

To reduce the outage time and enhance service reliability, it is essential to locate fault sections in a power system .Currently, past experiences are extensively used in fault diagnosis. These uncertainties occur due to failures of protective relays and breakers, errors of local acquisition and transmission, and inaccurate occurrence time, etc. An effective approach is thus necessary to deal with uncertainties in these expert systems.

Fault diagnosis in electric power system is a important operation. Every signal and step contain some uncertainties, which can be modeled by membership functions. Fuzzy set theory is used to determine fault sections in the approach. Membership functions of the possible fault sections are the most important factors in the inference procedures and decision making.

The system is useful for Modern power system. It is operated to maintain a unalterable conduct of electricity generation, transmission, and distribution. The operation of a power system is inevitably exposed to kinds of disturbances and faults, such as short-circuit of a transmission line or an unexpected generator outage, etc.

a. The given system examines the state of the system if it is in secure or insecure. For doing so it uses a mathematical algorithm in which it compares the system A with System B.

2. Where System A is defines the secure and insecure boundaries and System B defines the actual load of system.

3. After comparing the data of System A and System B, it generated the secure and insecure region of the system.

B. *Structure of the Fault Diagnosis System*

The fuzzy expert system structure is shown in Fig.1.Architecture consists of database, fault network identification ,inference engine, dispatcher interface ,fault determination.

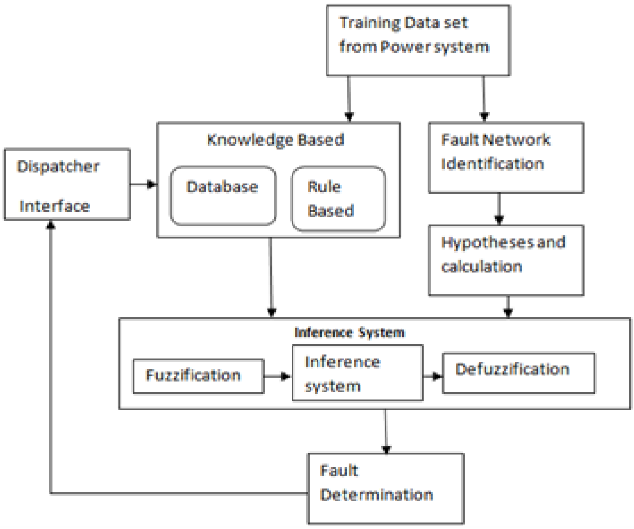


Fig 1.System Architecture

Database consists of training data sets of faults in power system ,whenever any fault is going to happen it will immediately compare with database and all hypothesis and calculation will be done and fault is determined. If any new fault is determined will get dispatch to database by dispatcher interface.

C. *Improved Pattern Discovery Algorithm.*

1. *Basic Concept:* Some of the basic conceptions of pattern discovery are shown below.

a. Event :An event E is a d-dimensional hyper-rectangle in a d-dimensional continuous sample space Rd

$$E = I_1 \times I_2 \times \dots \times I_d = \{X \mid x_i \in I_i, 1 < i < d\}$$

b. Volume*:* Let E be a d-dimensional event defined by the intervals { Ii }, i = 1 .....d; and Li be the length of the ith interval, then the volume of E is defined as

$$V = \Pi_{i=1}^{d} L_i$$

c. Observed Frequency: The observed frequency of event E_i, denoted as n_{oi}, is defined as the number of the sample points that fall inside of the volume occupied by E_i..

d. Virtual Frequency: Since Pattern Discovery aims to discover the patterns containing the organized information against the uniform random distribution, virtual frequency of an event E is formed to represent the uniform distribution frequency of the volume occupied by E.

$$N_{vi} = \frac{v_i \; n_+}{V_{TOT}}$$

2. *Residual Analysis:* The residual of the Event E_i is defined as

$$r_i = \frac{n_{oi} - n_{ni}}{\sqrt{\{n_{oi} + n_{ni}\}\{1 - 0.5 \times \{n_{oi} + n_{ni}\}/n_+}}$$

The residual is used to detect the departure of the event frequency from the uniform distribution statistically.

a. Significant Event (Pattern): An event E_i is a significant event at the α X100 percent importance level if ri > Z 1-a/2 .A significant event is also called a pattern.

b. Insignificant Event: An event E_i is an insignificant event at the α X 100 percent significance level if | ri |>$Z_{1-\alpha/2}$

The insignificant event indicates that the frequency of the event does not deviate from the uniformity.

c. Negative Significant Event: An event E_{i1} is a negative significant event at the α X 100 percent significance level if $r_i < Z\alpha/2$. The negative significant event indicates there is seldom or no sample points in the volume occupied by the event.

3. *Recursive Partition*: In order to seek the patterns in a d-dimensional subspace Ω , PD firstly partitions Ω into Q_d events by making each event contain equal number of sample points in each dimension (this is called equal frequency partition), where Q is the control parameter representing the number of events to be partitioned in each dimension.

4. *Centroid Deviation Analysis:* Although PD is powerful in discovering patterns of the data, we found that in some cases, PD will neglect some organized information of the data mistakenly. Thus we propose a centroid deviation analysis technique to enhance the pattern discovery ability of PD. When the number of the sample points contained in Ei is not too small, if the distribution of the sample points follows the uniform distribution, then the centroid of E_i cannot deviates from its center significantly; otherwise, E probably contains organized information.

5. *Integrating DSA Prior Knowledge into PD:* For enhancing PD to recognize the secure/insecure boundaries more accurate, this paper proposes another control condition to control the recursive partition process. It integrates the prior knowledge of the training data points (secure or insecure) into PD, and thus makes PD be semi-supervised.

6. Computing Procedures of the Improved PD:

a) Preparing the training data set, and maintain the control parameters of Pattern Discovery;
b) Set the whole training data set as the initial discovery space and inputs;
c) Divide each dimension of the current discovery space based on the equal frequency criteria;
d) Discover the event list of the current discovery space;
e) Set the event index i=1;
f) Get the ith event Ei from the event list;
g) Compute the residual value of Ei ;
h) If Ei satisfy the supervised condition, then set the current discovery space to Ei and go to Step c); otherwise, check the end conditions (a), (b), (d) and (d);
i) If any of the termination conditions is satisfied, then goto Step j); otherwise, set the current discovery space to Ei and go to Step(c));
j) Check if Ei is the last event of the current discovery space. If so, goto Step k); otherwise, set i=i+1 and goto Step (f));
k) Check if the current discovery space is in the top layer. If so, output the pattern discovery result and stop the algorithm; otherwise, set the parent space as the current discovery space and goto Step d).

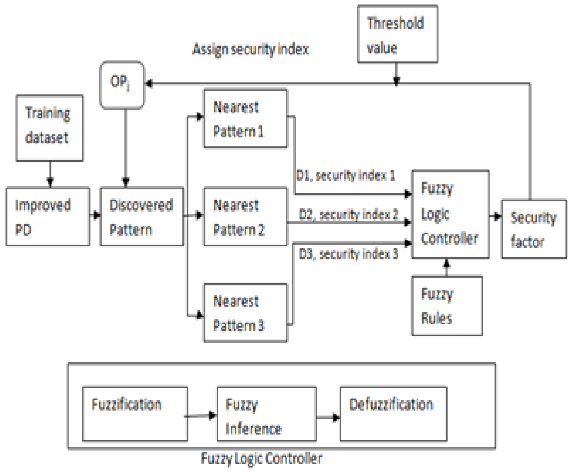


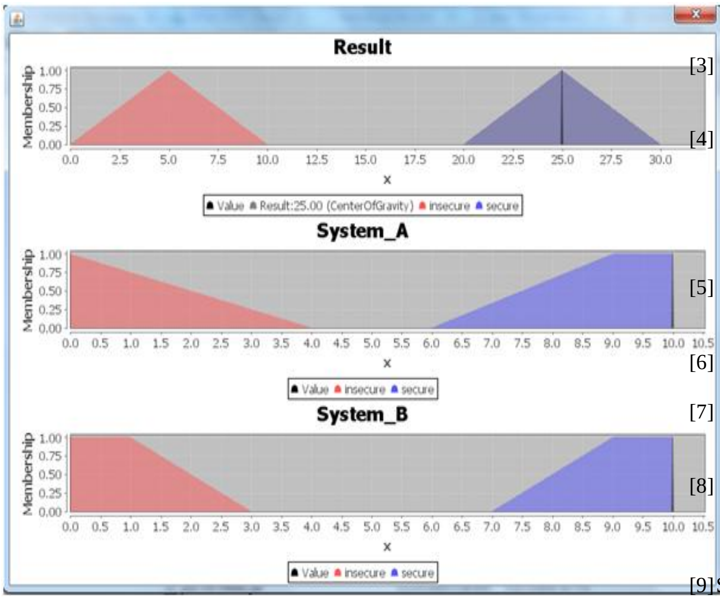
Fig 2.Work Flow

IV. WORK FLOW OF FUZZY CONTROLLER

Work Flow of Fuzzy controller is given in Fig 2 ,Training Data sets are given input to Improved Pattern then for given OP the 3 nearest patterns are found firstly The distances between OPj and them are computed respectively denoted by D1,D2,D3.Those distances are then fuzzified to be the fuzzy variables and input into the rule-based fuzzy controller. The fuzzy controller then selects a suitable fuzzy rule table according to the secure/insecure label of the 3 nearest patterns and performs the fuzzy inference. After the fuzzy inference process, the output is defuzzified to be the security factor of OPj , denoted by SF_{OPj} which is a real number within [0, 1]. By setting the threshold number *d* , the OP can be classified to secure or insecure by comparing the security factor and *d*.

V. RESULT OF PRACTICAL WORK

Practical work done is as shown in figure given below.Following figure shows the graphical representation of security index of given power system operating points.



VI. CONCLUSION AND FUTURE WORK

In this paper, we have improved pattern discovering algorithm by combining centriod deviation analysis technique and prior knowledge of traing data sets.This improvement can increase the performance when apply it to extract the patterns of data from a training data set of power system. Next, based on the results of the improved pattern discovery algorithm, a fuzzy logic-based classification method is developed to check the security index of a given power system operating point.

Contribution to society of fuzzy logic in power system is fuzzy logic is used to maintain the contigency ranking acording to severity.The post contingent quantities like line flows and bus voltages are expressed in fuzzy notation and further processed through fuzzy reasoning rules to achieve desired contingency list.A fuzzy neural network comprising of a screening and ranking module is proposed for online voltage contingency screening and ranking.Fuzzy logic used in stabilizing the load in Power system.Fuzzy Logic application in power system fault diagnosis.Hence there are many other applications of fuzzy logic in Power system and other fields too.

ACKNOWLEDGEMENT

We the authors give special thanks to those who contributed to this paper:FengJi Luo, ZhaoYang Dong, Guo Chen, Yan Xu, Ke Meng, YingYing Chen, K. P. Wong, and many others for their contribution in this field and sharing their knowledge

REFERENCES

[1] Lei Tang Iowa State University,2014,”*Dynamic security assessment processing system*”

[2] FengJi Luo, ZhaoYang Dong, Guo Chen, Yan Xu, Ke Meng, YingYing Chen, K. P. Wong, Fellow, 2015 ”*Advanced Pattern Discovery based Fuzzy Classification Method for Power System Dynamic Security Assessment*”

[3] J. McCalley, L. Tang, and S. Khaitan,” *Next generation on-line dynamic security assessment*” - parts III and IV, Final Report to Power System Engineering Research Center (PSERC), Aug. 2012.

[4] G. Andersson, P. Donalek, R. Farmer, N. Hatziargyriou, I. Kamwa, P. Kundur, N. Martins, J. Paserba, P. Pourbeik, J. Sanchez-Gasca, R. Schulz, A. Stankovic, C. Taylor, and V. Vittal.,”Causes of the 2003 “*Major Grid Blackouts in North America and Europe, and Recommended Means to Improve System Dynamic Performance”*

[5] LATHA.R,KANTHALAKSHMI.S,KANAGARAJ.J.,”*Design Of Power System Stabilizer Using Fuzzy Based Sliding Mode Control Technique”*

[6] Christian Andersson,2005”*Power System Security Assessment ,Application of Learning Algorithms”*

[7] S Kalyani, Member, IEEE, and K Shanti Swarup, Senior Member, IEEE,”*Power System Security Assessment using Binary SVM Based Pattern Recognition”*.

[8] N. Hatziargyriou1 J. A. Peas Lopes E. Karapidakis M. H. Vasconcelos ”*ON-LINE DYNAMIC SECURITY ASSESSMENT OF POWER SYSTEMS IN LARGE ISLANDS WITH HIGH WIND POWER PENETRATION*”.

[9] Shobha Shankar1, A. P. Suma2 , and Dr. T. Ananthapadmanabha3,”*Fuzzy Approach to Contingency Ranking”*,2009.

[10] S. KALYANI and K. SHANTI SWARUP. “*STUDY OF NEURAL NETWORK MODELS FORSECURITY ASSESSMENT IN POWER SYSTEMS”*

Triveni Ambre M.E scholar Computer Department, G.S.M Moze College of Engineering, Balewadi, Pune, Maharashtra India.

Priyanka More Department of Computer Engineering, G.S.M Moze College of Engineering, Balewadi, Pune, Maharashtra India