International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 2 Issue 9, September - 2013

Multi-fault Classification Using Various Soft Computing Techniques: A Survey

Mrs Sunita Kumari Padhi
Department of CSE,CET,BPUT
Bhubaneswar,Odisha

Mr Amitav Mahapatra
Department of CSE,CET,BPUT
Bhubaneswar,Odisha

Mrs Pranati Mishra
Department of CSE,CET,BPUT
Bhubaneswar,Odisha

Abstract

This paper presents a comprehensive study on fault classification using different soft computing techniques such as Artificial Neural Network, Fuzzy Logic Model, Particle Swarm Technique, p2p semantic mapping, and Support Vector Machine. For classification, support vector machine is the best technique in which, a hyperplane is constructed that has the largest distance to the nearest training data point of any class. Particle swarm optimization is a computational method that optimizes a problem by iteratively trying to improve a candidate solution. Improved particle swarm optimization is used for optimize the parameter of support vector machine. PSO can be used for clustering in which set of objects are grouped are more similar to each other. Feature extraction from train and test data, artificial neural network can be used.

1. Introduction

In this paper we discuss how to classify faults using various soft computing techniques. As number of fault arise in machines so that production rate reduces and cost of production, maintenance increases. So attenuations require for safety, reliability and fault tolerance for machines. For this fault detection and fault diagnosis system requires which is used for finding when faults and degradation occur and determine the cause of failure in manufactured respectively.

Support vector machines (SVMs) are a set of related supervised learning methods that analyze data and recognize patterns, used for classification. A support vector machine constructs a hyperplane, which can be used for classification, regression or other tasks. A good separation is achieved by the hyperplane that has the largest distance to the nearest training data points of any class.

Our survey focuses on multiple fault classification in complex system. Using support vector machine, it can be easy for classify the faults which achieves better generalization. For fault detection, feature extraction is the Key step which can be combined in efficient manner to improve veracity and reliability of fault diagnosis.

This paper is organized as follows. Based on the briefreview of previous work for classification of multiple faults in section 2, important conclusion in section 3.

2. Previous Research Work

In August 2002 Sanna Poyhonen, Marian Negrea Antero, Arkkio Heikki Hyotyniemi [1] proposed the paper comparison of reconstruction schemes of multiple svm's applied to fault classification of a cage induction motor. By using welch's method Power spectrum estimates of circulating currents in parallel branches of the motor are calculated and SVM's are trained to distinguish healthy spectrum from faulty spectra and faulty spectra from each other. A mixture matrix and neural network are compared in reconstruction the global classification decision from outputs of SVM's.

In March 2005 HU Zhong-hui ,CAI Yun-ze ,LI Yuangui ,Xiao ming[2] present the paper Data fusion for fault diagnosis using multi-class Support Vector Machines. These methods are applied for fault diagnosis of a diesel engine. The experimental results

of above approach showed that improve the diagnostic accuracy and the robustness of diagnosis.

In 2006 Abdul-Rahman Mawlood, MichaelWeiss and Nicola Santoro [3] proposed the paper Fault Classification in P2P Semantic Mapping. Global ontology used in the semantic interoperability among heterogeneous information sources is the reaching of a consensus among distributed ontoliges using local mapping and translation exchange. The investigate the construction of a flexible consensus system from distributed ontoliges in a peer-to-peer (P2P) network requires a semantic query processing with a fault-

Algorithms are effective in building a good TS fuzzy model

In 2008 Juan José Mora Flórez, Germán Morales España, Sandra Pérez Londoño [5] proposed a paper on Classification methodology and feature selection to assist fault location in power distribution systems. An application example illustrates the precision, by using simulated framework to locate the faulted zone. The proposal provides appropriate information for the prevention and opportune attenuations of faults, requires minimum investment and overcomes the multiple-estimation problem of the classic impedance based methods.

In August 2009 Zhan Yulong, Tan Qinming, and Liu Zuancang [6] proposed a paper on the Application of Binary Tree-Based Fuzzy SVM Multi Classification Algorithm to Fault Diagnosis on the Gearbox of Ships. Svm can't separate fuzzy information, but more useful for memory in calculation. Simulation experiments show that the algorithm has better anti-interference ability and classification effects than others.

In June 2009 Bilal Alatas , Erhan Akin[7] proposed the paper on Multi-objective rule mining using a chaotic particle swarm optimization algorithm In this paper, classification rule mining has been modelled as a multi-objective optimization problem with predictive accuracy and comprehensibility objectives. A search strategy, multi-objective chaotic particle swarm optimization (PSO) method has been introduced to mine classification rules within datasets, which intended to allow the PSO algorithm to return an approximation to the upper accuracy.

In January 2010 Xianlun Tang, Ling Zhuang, Jun Cai, Changbing Li [8] proposed a paper on Multi-fault classification based on support vector machine trained by chaos particle swarm optimization. The results of this paper show that the method of training SVM tolerance capability which can differentiate between permanent and non-permanent mapping faults.

In December 2007 Leandro dos Santos Coelho and Bruno Meirelles Herrera [4] proposed a paper on Fuzzy Identification Based on a Chaotic Particle Swarm Optimization Approach Applied to a Nonlinear Yo-yo Motion System. This paper proposes a method of nonlinear identification based on the TS fuzzy model and optimization procedure. By viewing experimental case study using above control system is analyzed. The numerical results presented here indicate that for nonlinear identification CPSO combined with Gustafson–Kessel (GK) clustering using CPSO is feasible and the proposed fault classification model outperforms the neural network trained by chaos particle swarm optimization and least squares support vector machine, the precision and reliability of the fault classification results can meet the requirement of practical application.

In November 2010 Jiang Cui, Youren Wang [9] proposed a paper on A Novel Approach of analogue fault classification using A support vector machine classifier. In this paper the conventional one-against-rest SVC is resorted to perform a multi-class classification task. The investigation shows that the wavelet analysis can be used as a tool of feature extractor and this pre-processor can improve the fault classification resolution of the analogue circuits .The SVC can be applicable to the domain of analogue fault classification and this novel classifier can be viewed as an alternative for the back-propagation (BP) neural network classifier.

In 2010 Min-Yuan Cheng, Kuo-Yu Huang, Hung-Ming Chen [10] proposed the paper on a particle swarm optimization based chaotic k-means evolutionary approach. KCPSO, which is chaotic mapping with ergodicity,irregularity and the stochastic properties in PSO, contributes to global search while K-means with clustering properties in PSO results in rapid convergence. Diversity is implied through Unpredictability and grouping principle underlying chaotic mapping and K-means methods and convergence potential within the swarm which inevitably lead to a desirable optimal solution. By comparing multidimensional search space and with original PSO, the conclusions reported that the proposed KCPSO algorithm could improve the search performance on the benchmark functions significantly, and show the effectiveness of solving optimization problems.

In 2011 Wei Yin, North western Polytech Univ., Xi"an ,Weiguo Zhang , Xun Sun [11] proposed a paper on A SVM- Based Multiple Faults Classification Scheme Design in Flight Control FDI System. This paper focuses the application of the Support Vector Machine (SVM) algorithms to the flight control fault diagnosis and isolation (FDI) system and the scheme of identifying multiple flight control system faults. Based on multi-class LS-SVM, a flight control system FDI synthesis method classified these fault data for reconfiguring control system efficiently. Through discussing some of the differences between varieties of kernel functions, we give a solution which needs to be studied further by using fuzzy system.

In 2011 Ahmed, Mahmud, Abdusslam, S.A., Baqqar, Mabrouka, Gu, Fengshou and Ball, Andrew [12] proposed a paper on Fault Classification of Reciprocating Compressor Based on Neural Networks and Support Vector Machines.. This paper focuses on the development of an advanced signal classifier for a reciprocating compressor using vibration signals which overcomes consuming more energy and server damage. For trained and tested data of feature extraction and fault classification, Artificial Neural Networks (ANN) and Support Vector Machines (SVM) have been applied,. The accuracy of both techniques is compared to determine the optimum fault classifier, Which show classification rate accuracy is up to 100% for both binary classes that is single and multi class.

In February 2011 Hammoud Aljoumaa and Dirk S offker [13] proposed a paper on Multi-Class Classification Approach based on Fuzzy-Filtering for Condition Monitoring . Desired goal of this paper is to design a condition monitoring system based on suitable and available signals, related measurements experiments, and classifying information of the system to be monitored. The key idea of this contribution is the generation of a set of features to distinguish related different states of the system.

In 2011 Prarthana Warlyani, Anamika Jain, A.S.Thoke, Member IEEE, and R. N. Patel, Member IEEE[14] proposed the paper Fault Classification and Faulty Section Identification in Teed Transmission Circuits Using ANN. The proposed algorithm uses the voltage and current signals of each section measured at one end of teed circuit to detect and classify Double line to ground faults. ANN has the ability to classify the nonlinear relationship between measured signals. The adaptive protection scheme based on application of ANN is tested for double line to ground faults, varying fault location, fault resistance and fault inception angle. The entire test results clearly show that the fault is detected and classified within one cycle; thus the proposed adaptive protection technique is well suited for teed transmission circuit fault detection and classification.

In October 2011 GAO Cheng, HUANG Jiao-ying, SUN Yue, DIAO Sheng-long [15] proposed a paper on Particle swarm optimization based RVM classifier for non-linear circuit fault diagnosis. For non-linear circuits A relevance vector machine (RVM) based on fault diagnosis method was presented. For simplify RVM classifier, parameters selection based on particle swarm optimization (PSO) and pre-processing technique based on the kurtos is and entropy of signals were used.. By analyzing the output signals, the proposed method can detect and identify faulty components in circuits. The results indicate that the fault classes can be classified correctly for at least 99% of the test data in example circuit.

In May 2012 Li-Yeh Chuang, Yu-Da Lin, and Cheng- Hong Yang, Member, IAENG [16] proposed a paper on Data Clustering Using Chaotic Particle Swarm Optimization. Gauss chaotic map particle swarm optimization (Gauss PSO) method is proposed for clustering, which uses a Gauss chaotic map that relies on this parameter to update the positions and velocities of the particles and the map provides the significant chaos distribution to balance the exploration and exploitation capability of search process. In the study, eight different clustering algorithms were extensively compared on six test data sets. The results indicate that the performance of the Gauss PSO method is significantly better than the performance of other algorithms for data clustering problems.

In April 2013 Mingwei Li, Haigui Kang, Pengfei Zhou, and Weichiang Hong [17] proposed a paper on Hybrid optimization algorithm based on chaos, cloud and particle swarm optimization algorithm. While the PSO algorithm evolves acertain of generations, hybrid optimization algorithm applies that can mapping to implement global disturbance of the poorer individuals, and best individual is obtained from new swarm by employing the cloud model to execute local search of individual. For this new swarm, the evolution operation is maintained with the PSO algorithm, using the two parameter of *pop distr and mix gen* to balance the global and local search capacity and to control mixing times of the algorithm respectively. The comparative analysis is carried out on the basis of 4 functions and other algorithms from them this algorithm shows faster convergent speed.

3. Conclusion

SVM is a new machine-learning tool for classification, which is powerful for the practical problem with complex system machines. Using chaos particle swarm optimization with SVM is easy to implement for multiple fault classification. This survey paper analyses how to classify the fault using different soft computing technique and its applications.

Acknowledgement

"I would like to thank all those who co-operated with the conduct this survey Without their help, this survey could not have been carried out."

References

[1].Sanna Poyhonen,Marian Negrea Antero,Arkkio Heikki Hyotyniemi, comparison of reconstruction schemes of multiple svm's applied to fault classification of a cage induction motor, Helsinki University of Technology Control Engineering Laboratory Espoo August 2002 .

[2].HU Zhong-hui (胡中辉)†, CAI Yun-ze (蔡云泽), LI Yuan-gui (李远贵), XU Xiao-ming (许晓鸣), Data fusion for fault diagnosis using multi-class Support Vector Machines, Journal of Zhejiang University SCIENCE,ISSN 1009-3095.

[3] Abdul-Rahman Mawlood, MichaelWeiss and Nicola Santoro,Fault Classification in P2P Semantic Mapping.

[4] Leandro dos Santos Coelho and Bruno Meirelles Herrera, Fuzzy Identification Based on a Chaotic Particle Swarm Optimization Approach Applied to a Nonlinear Yo-yo Motion System, IEEE TRANSACTIONS ON INDUSTRIAL ELECTRONICS, VOL. 54, NO. 6, DECEMBER 2007

[5] Juan José Mora Flórez, Germán Morales España, Sandra Pérez Londoño, Classification methodology and feature selection to assist fault location in power distribution systems, Rev. Fac. Ing. Univ. Antioquia N.° 44. pp. 83-96. Junio, 2008.

[6] Zhan Yulong1, Tan Qinming2, and Liu Zuancang3, The Application of Binary Tree-Based Fuzzy SVM Multi Classification Algorithm to Fault Diagnosis on the Gearbox of Ships, Proceedings of the 2009 International Symposium on Information Processing (ISIP'09) Huangshan, P. R. China, August 21-23, 2009, pp. 372-376

[7] Bilal Alatas , Erhan Akin , Multi-objective rule mining using a chaotic particle swarm optimization algorithm, Knowledge-Based Systems 22 (2009) 455–460.

[8] Xianlun Tang , Ling Zhuang, Jun Cai, Changbing Li ,Multi-fault classification based on support vector machine trained by chaos particle swarm optimization, Knowledge-Based Systems 23 (2010) 486–490.

[9] Jiang Cui, Youren Wang, A Novel Approach of analogue fault classification using A support vector machine classifier, *Metrol. Meas. Syst.*, Vol. XVII (2010), No. 4, pp. 561–582.

[10] Min-Yuan Cheng, Kuo-Yu Huang, Hung-Ming Chen, particle swarm optimization based chaotic k-means evolutionary approach, 27th International Symposium on Automation and Robotics in Construction (ISARC 2010).

[11] Wei Yin ; Northwestern Polytech. Univ., Xi"an ; Weiguo Zhang ; Xun Sun, A SVM- Based Multiple Faults Classification Scheme Design in Flight Control FDI System.

[12] Ahmed, Mahmud, Abdusslam, S.A., Baqqar, Mabrouka, Gu, Fengshou and Ball, Andrew , Fault Classification of Reciprocating Compressor Based on Neural Networks and Support Vector Machines.

[13] Hammoud Aljoumaa and Dirk S offker, Multi-Class Classification Approach based on Fuzzy-Filtering for Condition Monitoring, IAENG International Journal of Computer Science, 38:1, IJCS_38_1_08

[14] Prarthana Warlyani, Anamika Jain, A.S.Thoke, Member IEEE, and R.N.Patel, Member IEEE, Fault Classification and Faulty Section Identification in Teed Transmission Circuits Using ANN, International Journal of Computer and Electrical Engineering, Vol. 3, No. 6, December 2011.

[15] GAO Cheng, HUANG Jiao-ying, SUN Yue, DIAO Sheng-long , Particle swarm optimization based RVM classifier for non-linear circuit fault diagnosis,J. Cent. South Univ. (2012) 19: 459−464.

[16] 2012 Li-Yeh Chuang, Yu-Da Lin, and Cheng-Hong Yang, Member, IAENG,Data Clustering Using Chaotic Particle Swarm Optimization, IAENG International Journal of Computer Science, 39:2, IJCS_39_2_08.

[17] Mingwei Li,Haigui Kang, Pengfei Zhou, and Weichiang Hong ,Hybrid optimization algorithm based on chaos, cloud and particle swarm optimization algorithm, Journal of Systems Engineering and Electronics,Vol. 24, No. 2, April 2013, pp.324–334