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A Literature Survey on Techniques of Power Theft Detection

Prof. Vaibhav Baburao Magdum[1], Prof. Ravindra Mukund Malkar[2]

Assistant Professor, Electrical Engineering Department,

DKTE Society's Textile and Engineering Institute, Ichalkaranji, (MS), India.[1,2]

Abstract: Electricity companies lose much of their income, either through illegal connections or dishonesty of customers for personal gain. Investigators are deploying various systems to detect theft and reduce non-operational losses. Methods such as Support Vector Machine (SVM), Fuzzy C-means Clustering, Fuzzy logic, user profiling, genetic algorithm, etc. are used to detect electricity theft. There are two drawbacks to using these systems based on this methodology: the accuracy and the infrastructure required to run them, such as smart energy meters, etc. Using the current analysis of the system, a new system can be proposed which aims to improve the accuracy of theft detection

Keywords: Include at least 4 keywords or phrases.

I. INTRODUCTION

The transmission and distribution of electricity lead to large power losses. The amount of this loss increases day by day as the electricity authorities suffer losses in their profits. A new method is proposed to identify fraudulent customers. In general, there are three main steps that lead to potential fraudulent customers. Customer billing data is collected from various sources such as sensors, manually, etc. This collected data is in raw form that has been pre-processed. The pre-processing module is used to perform data cleansing that addresses issues such as missing values in customer billing data. Data integration is performed to represent the data in some form that is necessary to further process the data. The detection module, as its name suggests, is used to find the consumption model anomaly through various mechanisms. As with the hardware engineering, it is related to the change of physical conditions in the data-based technique, it is related to the change in electricity consumption at any time based on these analyses, potentially fraudulent customers are identified. The post-processing of data generally involves improving the accuracy of detecting potentially fraudulent customers of the suspicious customers generated in the detection module and finally generating the output of potential suspicious customers.

II. LITERATURE SURVEY

The Following is brief description of work done on theft detection models by various researchers: -

[1] This paper presents analysis of latest applications and developments of mixtures of normal (MN) distribution in finance. Mixtures of normal model is flexible to include variety of shapes of continuous distributions, and to capture skewed, leptokurtic, and multimodal characteristics of monetary time series data. The MN-based evaluation does the task efficiently with the regime-swapping literature. Following are two categories under which survey is done (1) Financial modelling and its uses. And (2) minimum-distance estimation. The mixtures of Normal (MN) family uses are multi-disciplinary that include diverse fields like astronomical science, biological science, economical analysis, engineering and technology. Even though we are able to interpret the observed financial data as a mixture of different information components, this, to a certain level, remains to this level.

[2] This paper uses the concept of genetic algorithm is blended with the Support Vector Machine (SVM). The billing data obtained from the authorities was firstly filtered with criteria's like neglect customers having no usage since 25 months, etc. Then the load profiling is done .then the feature extraction and data normalization was done. Then the SVM classification was done on the data obtained and the data was divided into 4 classes. Class 1 being highly potential fraudulent customers and class 4 as low potential fraudulent customers. Then the Genetic Algorithm (GA) optimization is used to reduce the hyper parameters of the SVM to a single chromosome and thus the fraud is detected with optimal efforts but this method has an accuracy issue as SVM is not very accurate mechanism for classification though the GA reduces the efforts the accuracy remains poor.

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[3] Describes the concept of monitoring of power usage for every half-hour, it needs the smart power meters which could transmit the usage data of customers wirelessly to the power authorities. The data thus obtained would be used for load profiling of the customers. This paper uses the concepts like fuzzy logic and intelligent systems. The data used for getting the results is for 1 month. firstly, the data was obtained from the intelligent meters. Then the data was pre-processed for correlating with load profiling. Then with the help of these load profiling the abnormality in consumption was found out and the customer was categorized into 5 types using fuzzy logic and thus the fraud was detected but in such type of mechanisms there is great requirement of infrastructure and also the results may not be accurate as the month taken for reference to be tested may be the vacations month where the consumption is more than the normal consumption.

[4] States the idea of computational techniques to classify the electricity consumption profiles of users. The paper uses two-step process to reach to the results. Firstly the c-means based on fuzzy clustering, is performed to find customers with similar usage profiles and then fuzzy-classification is executed on the fuzzy cluster values and fraud matrix values using distance based approach. Then the gradation is done on the bases of the deflection. The greater the value of the grade the greater is the probability of fraud .the fuzzy c-means clustering technique used for clustering gives the higher chances of likeliness detection between the normal and abnormal behavior of the customers usage. The profiles for the user are made from usage of five attributes mainly average consumption of specific client in 6 months, maximum consumption in 6 months, standard deviation, sum of inspection remarks in last six months, average power consumption of that area also the clustering is done using these three parameters. The classification is performed on the basis of 12 months data after the data used for classification. Thus after this we get the degree of abnormality in the usage and by use of proper threshold the faulty customers could be found out. But this method has a drawback in terms of accuracy issues though fuzzy-clustering and classification gives good accuracy but there are still the chances that the training set fuzzy clusters may not yield an accurate load profile as only 6 months data cycle is used.

[5] This paper describes a portfolio optimization system by using Neuro-Fuzzy technique in sequence to manage stock portfolio. The suggested portfolio minimization approach Neuro-Fuzzy System reasoning in order to gain greater profit from the stock portfolio, Now, Neuro Fuzzy model produces much higher certainty when comparison with other envelop models. In this paper the given method is invented by BSE Sensex stock index. Experimental outputs show that the performance of models, as evaluated by its return on asset and risks. Thus, the results obtained using the proposed technique in performance opinion experiments applying live stock exchange data profited significantly higher return on investment values compared against other portfolio models.

[6] This paper describes Software estimation Correctness is the greatest provocation for software builder. It can study the project determination like source allotment and direction which can be used to deploy the project with respect to time, within the duration of the time .In this paper, we proposed a new system using fuzzy logic moto to estimate the essential factors of software try evaluation such as cost and time and neural network system used for carrying out the desire estimations for developing a program activity. In this paper we narrate neural network structure using Bayesian Regularization method produces minimized condition numbers as compared to the other fuzzy models having enrolment objective, which reflect abandon at some points and it is at these dots that the status number increases

[7] This paper describes Fuzzy logic based power theft detection and power quality improvement technique. It analysis comparison between the whole load given by the administration power plant and the total load used by the user and the flaw signal is used to display the theft of power. Load (energy) and voltage are given as input to the Fuzzy logic controller and the corresponding variations in output voltage is provided by the controller to increment the power nature and to decrease the theft of powers. Replica are carried out using MATLAB and the output of the simulations are provided. It helps us to predict the efficient use of intelligent control in electrical models. Thus, the application of inventive Authority in electrical model can improve the power efficiency to a large extent, at the same time it can secure a lot of non-legal activities. The power theft surveillance will be a peer of a country's economy in executing the necessity for power generation. Hence this formation of automatic intelligence in power systems will be a great

[8] The paper uses the Atkinson index approach for measuring the ill outcomes. As Atkinson index is mainly associated with the distribution of quantities over a spread in terms of income. This approach with the help of the concepts like relative Lorenz curve is used to apply the Atkinson index efficiently to measure the values like pollution. But however due to this transformation the Atkinson index will be used solely for deriving the bad outcomes only there would be no comparison between good and bad outcomes by use of this approach. This this would be beneficial for us to detect the unequal distribution in terms of electricity efficiently by use of this approach.

[9] A comparison has been done on the basis K-Means and hierarchical clustering on intrusion datasets. Hierarchical clustering: When event occurs, it is the based on the nodes which detect it will be formed and the election algorithm

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elects a Coordinator for each cluster which is Cluster Head (CH) and deliver Cluster Configuration Message (CCM), identified as <Type, ID, HTT, State, W I>, where ID is the identifier and W is the energy factor for each node u. The CH has the extreme energy among all the nodes in the cluster. K-means: To find the cluster consider the consume data according to that from a cluster by using distance measure from a group. Similar data of consumer from a one cluster and dissimilar data of consumer from another cluster. K-means clustering is the simplest unsupervised clustering technique. This algorithm takes parameter k as input and partition it into n dataset into k cluster so to obtain the intra-cluster equality is high and inter- cluster equality is low. K is a positive integer number given in advance. It takes minimum time as compared to the hierarchical clustering and yields very better results.

[10] A comparison is done between K-Means and C-Means clustering on invasion-based datasets. The dataset contains all inequality measures of K-Means and C-Means clustering. The result of these clustering algorithms is analysed on the basis confusion matrix. this technique are implemented on the basis of three intrusion datasets namely KDDCup99, NSLKDD, and GureKDD.by using different pre-processing techniques This datasets are pre-processed and normalized, and then select input as the models. It can verify on the basis of their clustering accuracy and computational time. The main goal of clustering is to find out the similar and dissimilar objects. The performance of algorithm is checked on basis of similarity between the objects in the cluster. For comparison of K-Means and C-Means, we will select the non-similar measures which gives better results. Like Euclidean distance gives greater accuracy than other measures in KDD Corrected data set. Same way choose second option using K-Means provides most favourable results. The result shows that K-Means provides better clustering accuracy as comparison to C-means. So, to design intelligent invasion detection software's K-means is a good option.

[11] The paper shows that the Atkinson Index is still the best way to find out the in-equality in distribution of the particular values. The Gini index is also a nice method but it has flaws like in inequality interpretation there are values where calculation of Gini index is not convenient and causes computational problems. Move over the Atkinson index is very easily decomposable to apply to various changes but with Gini index the decomposability is restricted. So the conclusion from this can be stated that Atkinson index is better than Gini index for inequality distribution method.

[12] The paper uses the approach based on power line communication principle which is use for detecting theft in electricity. A high frequency signal is introduced in the distribution network which changes its amplitude and frequency as the load in the lines increases or decreases. The changes will be detected through the gain detectors if any illegal connection is made between the poles then there will be modification in the values of gain and through which the illegal connection in the electricity will be discovered and proper action will be taken by the authorities to neutralize such connection but this approach is not tried for the theft detection for the customers illegal use and it is infrastructure based.

[13] Uses the concept of customer's historic usage pattern of electricity to create the user load profiling information which is used to detect the unusual flow of electricity and thus provides the class of customers which could be further synthesized to detect possible fraud customers. The paper uses many concepts like Extreme Learning Machine, Support Vector Machine. There are various process carried out in these process of detection. Firstly the usage data of customers is pre-processed. The processing is done in three steps Data Selection, Data Separation and Data Normalization. Then there is the process of feature selection which automatically takes the important features of the data. Then the data is categorized by the abnormal usage patterns by using ELM. Then the categorized data is further classified by SVM to detect the possible fraud in electricity. But as we are using SVM. The accuracy of detection decreases as SVM is not accurate in classifying data to the extent so there is possibility of getting failure in detection of fraud.

[14] In this paper, a comparison has been done between K-Means and N-K Means clustering on the basis of time and speed factors. K-means: It is a very efficient technique used to split out uniform and no uniform data into groups based on Centroids or means of clusters. N-K means: It is proposed on the basis of normalization. This algorithm applies normalization which is useful for clustering on the basis of available data and weight it also evaluates initial centroids. K-means produce efficient results after the changes are made in the databases. We apply converted algorithm on the basis of weighted average core of dataset with calculation of initial centroids. Before applying N-K means algorithm we normalize and pre-process the dataset. Mainly it depend on proposed method in three stages. In first stage, convert raw data into understandable format for that data pre-processing techniques are used. In second stage, into a specific range normalization is perform to get the data objects in typical form. In third stage we apply the N-K means algorithm to obtain the clusters. Paper presents efficient algorithm where we have first pre-processed our dataset on the basis of normalization technique and then generated effective clusters. This is done by assigning weights to each attribute value to find the standardization. This algorithm has proved to be better than traditional K-means algorithm on the basis of execution time and speed and Experimental results prove the proposed N-K means algorithm has better time complexity and overall performance comparing to K-means clustering.

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[15] Segmentation and clustering algorithms that depend on Gaussian kernel function as a way for constructing affinity matrix, like spectral clustering algorithms suffer from the poor estimation of parzen windows. The final results depend on this parameter and change with change in its value. This paper uses optimization techniques in new algorithm for estimations, we construct a vector, each corresponding to its row in a dissimilarity matrix used to build an affinity matrix with the help of Gaussian distribution function. Our algorithm shows that, it is directly proportional to difference of squires of maximum and minimum distance of i 'th row and j'th column and also its inversely proportional to two log of ratio of maximum distance squire to the minimum distance squire is the optimum estimation, and we introduce more than one approach to calculate global value for s from this vector. The affinity matrix produced using proposed algorithm is actual useful and contains additional data like the number of clusters complete clustering without depending on other algorithms is not possible

[16] This paper describes the concept of Neuro-fuzzy Constructive Cost Model is proposed to improve the effectiveness of risk analysis method. The Neuro-Fuzzy Risk identification which merges the non-linear information characteristic of neural networks with fuzzy logic model that has potential to handle the tender and grammatical data and creates risk rules using Artificial Neural Network method to improve the accuracy of risk estimate technique. This paper narrate the progress required for implementing the Neuro-Fuzzy Risk technique on the native fuzzy Ex-COCOMO methodology. Neuro-fuzzy method for risk identification that merges the fuzzy logic with the neural network model to correctly reduced the software project in specific risk group. Future research in this era, which are made to increase the accuracy and awareness of this methodology, can be possible by applying Genetic Algorithm method to obtain the structural and parametric values of neural network used.

[17] This paper states the thought of using temperature based energy meters for guessing the theft in electricity by using smart meter. It is model based on advancement of constant resistance based technical loss evaluation. They have used the model and done advancement in calculating resistance by including the temperature variable. The variables are dependent on the material used for making transmission lines, thus by calculating the variables and approximating the circuit the theft can be predicted. The model is worthy for prediction if the theft is more than 4%. The model makes use of user power usage profiling as every 30 minutes the data from meter is collected and also the temperature the temperature profile is given as input. This method is good for detecting the illegal connections in the grid but the complexity and infrastructure need is much more. As there is need of circuit calculations and approximations are also needed to be done.

[18] This paper introduces the concept of dynamic programing approach which is used to detect the fraud in the smart meters. The technique is used to minimize the Feeder Remote Terminal Unit (FRTU) which are used to determine the theft prone zones in the smart meters. Due to which the price of monitoring will be significantly reduce. It uses the time based approach to determine the users potential to theft by comparing the readings of previous 1 year for the particular time and then calculates the probability that the meter is by passed. Then these values are used using dynamic programing to place the FRTU at proper locations as the distribution network is tree like in the form the efficiency of dynamic programing approach is very good but it can be applied to smart meters only and more over it can give false alarm when the usage of the user changes.

III. CONCLUSION

In this paper, we have looked at various methodologies that can be useful in solving the given problem. Recent research on electricity theft detection is increasingly focused on building systems as the user of the electricity distribution organization will use the product to identify potential defective customers with their contact details to minimize distribution and distribution losses. This product helps distribution companies optimize the use of electricity theft detection tools. In order for any of these systems to work, they need methods of detecting a faulty user from a particular input data set. In this article, we discuss a representative cross section of electricity theft detection techniques. The study of different techniques is underway to propose the new technique which should have greater precision to detect the theft of electricity. The technique would therefore be useful for energy authorities to further minimize non-technical losses in electricity distribution.

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BIOGRAPHY

Mr. Vaibhav Baburao Magdum is M.E. in Electrical Power system from PVGCOET, Pune (MS). He is B.E. Electrical from AISSMS, COE, Pune, (MS). Presently he is working as Assistant Professor in DKTE Society's Textile & Engineering Institute, Ichalkaranji, An Autonomous Institute affiliated under Shivaji University, Kolhapur (MS). His research areas include Electrical Machines, Drives, Power System, Switchgear & Protection. He has published and presented the papers in International Journals and International/National conferences. He is a Life member of Indian Society of Technical Education, New Delhi.

Mr. Ravindra Mukund Malkar is M.E. in Electrical Power system from Walchand COE, Sangli (MS). He is B.E. Electrical from MSBCOE, Latur, (MS). Presently he is working as Assistant Professor in DKTE Society's Textile & Engineering Institute, Ichalkaranji, An Autonomous Institute affiliated under Shivaji University, Kolhapur (MS). His research areas include Harmonics, Transmission Lines and Power system. He has published and presented the papers in International Journals and International/National conferences. He is a Life member of Indian Society of Technical Education, New Delhi.