Comparative Research on the Techniques of Electricity Fraud Detection Using Different Machine Learning Techniques

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Abstract: **The vulnerability of power theft has hampered the electricity industry for decades. It obstructs social progress by having varying degrees of impact on home, commercial, and industrial customers. Sneak thieves have caught up with contemporary metering systems, putting electricity suppliers in trouble financially. This comparative analysis is the first step in the presentation of principles. Theft of electricity has serious consequences for the power grid's proper operation as well as the economic benefits of power corporations and commercial power service providers. An effective anti-power-theft algorithm is required for tracking power usage statistics in order to detect electricity power theft. In this literature review, we differentiate the Support Vector Machine (SVM) algorithm with other techniques for detecting abnormal usage among consumers (i.e., electricity fraudsters) in time-series data on power consumption. The results show some combinations can reach significantly better values than others, comparing both the balancing techniques for a same machine learning method itself as well as comparing these combinations between themselves.**

Indexed Terms- **Support Vector Machine (SVM), Quality of experience (QoE), Non-technical losses (NTL)**

I. INTRODUCTION

Electricity is a necessary component of development and sustainable economic expansion. India has been heavily reliant on its power sector as one of the world's major consumers of electricity. India's power demand is expected to grow at a rate of 5% every year through 2030.

The role of electricity in development and economic growth is critical. India has been heavily reliant on its power sector as one of the world's major consumers of electricity. Through 2030, India's power demand is predicted to grow at a tempo of 5% per year. The government must develop an efficient, resilient, and financially sound power supply infrastructure to support the sector's needs, which have been stated by ambitious targets.

To some extent, unpredictable electrical supply can be linked to theft. Power theft has become a real sport for residential, commercial, and industrial users alike. Thanks to the ubiquity of power theft, the lack of a strong vigilance mechanism, and the difficulties of identifying and apprehending perpetrators. Power theft has resulted in considerable financial losses for the government, as well as suppliers and owners. As a result, they are becoming less able to maintain infrastructure and invest in power generation, resulting in increased power shortages and disgruntled customers. As a result, the rising threat of power theft has become a rallying cry for a comprehensive power theft management approach.

The Indian electrical sector loses $16.2 billion each year to theft, according to Northeast Group. "Power theft ends up costing India more money than any other country in the world," asserted the Northeast group's president. Maharashtra, which encompasses Mumbai, loses $2.8 billion per year. In the United Areas, total losses in transmission and distribution are approaching 23%, with up to 50% losses in some states.

According to the World Bank, power theft significantly decreases India's GDP by 1.5 percent. According to a recent assessment, 40% of electricity is still underappreciated, and a quarter of the electricity produced is either lost in transmission or stolen. E-rickshaw theft costs Delhi RS 150 crore per year, according to a DISCOM and power generation expert. Even though there are a plethora of them, only around a quarter of them are registered in India.

A great number of people are hoodwinked when electricity is stolen. Not only in rural areas, but even in cities, power theft is common. Urban slums are breeding grounds of electricity theft, according to a Times of India report [7]. The Calcutta Electricity Supply Corporation discovered in 2002 that affluent residential areas account for the majority of electricity theft. The majority of the stolen consumers live in premium urban communities including Alipore, Park Street, Shakespeare Sarani, and others, according to a raid. The government has been unable to address the issue of electricity theft despite its best efforts.

II. LITERATURE REVIEW

The researchers recently been using a variety of techniques to find the electricity theft. State-based approaches, game theory, and machine learning can be used to categorize these methods. The state-based systems detect electricity theft utilizing additional hardware, such as wireless sensors, distribution transformers, and smart meters [8]. Because additional hardware equipment is required to accomplish this methodology, the process of deployment is considerable. It is supposed that the transmission network and the energy thieves are playing a game in a fashion that is based on game theory. The difference in electricity usage patterns between malicious and lawful users can be used to predict the outcome of a game [9]. It must define an objective functions for each

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player in a game, which is a difficult task. For ETD, machine learning technologies are commonly employed. They can also be divided into supervised approaches (classification) and unsupervised techniques (clustering), which are then used to classify fraudulent and legitimate customers from unlabeled datasets.

III. SUPPORT VECTOR MACHINES (SVM)

In this section, we will discuss technology used for automated vehicle along with the different levels of automations.

Support-vector machines (SVMs) are supervised learning models for classification and analysis of regression in machine learning founded by Vladimir Vapnik and colleagues from AT&T Bell Laboratories. Relies on empirical learning frameworks or VC theory created by Vapnik (1982, 1995) and Chervonenkis, SVMs are one of the most accurate prediction systems.

A set of simulation instances is provided, each of which is labelled as falling into one of two categories, SVM training algorithm produces a model that allocates upcoming instances to one of 2 categories, resulting in a binary linear classifier that is non-probabilistic, given a sequence of training examples, each one was classified into one of two groups.

SVM distributes training examples to coordinates in space to maximize the difference between the two categories. After that, additional samples are projected into same space and classed based upon what side of the divide they fall under.

IV. DIFFERENT MODELS FOR NTL (non-technical loss) DETECTION

The first model is Boolean logic-based CHOICE Technologies product that serves as a baseline. In the second model, it is expanded to fuzzy logic to smooth the decision-making process. A Support Vector Machine [5], a cutting-edge machine learning technique, is the third model.

1) **Boolean logic:** The model is a hand-crafted expert system made up completely of combinations of (in) equality conceptions established by CHOICE Technologies team of **experts**.

2) **Fuzzy logic:** Expert knowledge has long been utilised in a gentler judgement process in process control using fuzzy systems. They allow people to connect with different types of items, breaking down barriers and creating affiliation a matter of degree.

3) **Support Vector Machine:** A maximum margin classifier, or something like a Support Vector Machine (SVM), separates classes as much as feasible. As a result, compared to other classifiers like neural networks, an SVM is less prone to overfitting. The separating hyperplane is held in place by support vectors. They make up a modest proportion of training scenarios in reality

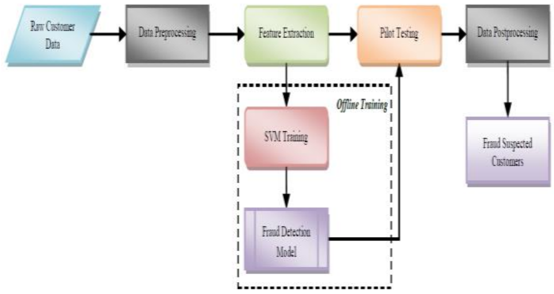

Figure 1: Fraud electricity customer detection framework

Table 1. Overview of performance indicators and set of data characteristics in residential type

Model & Ref	Recall (%)	Accuracy (%)	Source	No. of Customers	Length (months)	Simulation Environment
Genetic-SVM [2]	62	-	TNBD Data set	186,968	25	-
Support Vector Machines (SVM) [3]	53	72.60	TNBD Data set	186,968	25	LIBSVM v2.86
SVM (Gauss)[4]	64	77.41	TNBD Data set	186,968	25	LIBSVM v2.86
SVM-Fuzzy [5]	72	-	Electricity Provider in Brazil	36173	25	-
Boolean Rules fuzzy logic SVM [6]	-	-	Dataset collected by CER in Ireland	700K	48	MATLAB LIBSVM

V. RESULT

The following performance parameters were considered in the evaluation.

1) **Power utilization factor:** It's the proportion of required power to available power.

2) **Customer satisfaction:** It is determined by the Quality of Experience. The quantity of electricity delivered in a day is referred to as QoE. Customer satisfaction is high when there are few power outages. We analyze consumer satisfaction using demand response analysis. We believe that customer satisfaction can be achieved if power is distributed according to consumer wants.

VI. CONCLUSION

In this study, we offer three models for identifying NTLs in large data sets: Boolean, Fuzzy, and Support Vector Machine. The enhanced fuzzy and SVM models were tested on extremely unbalanced real-world consumption data with fluctuating NTL proportions, in contrast to other reported results. The upgraded models will be included in a CHOICE Technologies product soon. Future smart meter studies will need the contribution strategies to evaluate their efficiency in unbalanced and big real-world set of data.

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