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EFFECTIVE PREDICTION OF ELECTRICITY CONSUMPTION BASED ON EFFICIENT ANALYSIS OF HOUSEHOLD CHARACTERISTICS

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ABSTRACT: ***Demand prediction is an important aspect in the development of any model for electricity planning. The analysis of customer load profile and load estimation is an important and useful area of electricity distribution technology and management. In our system we are trying to analyze particular household data so as to define its load profile based upon various factors and try to predict its future electricity usage so as to help the consumer conserve energy and help producer to meet demand side requirements and accordingly set tariffs with the help of prediction model. The model which will be used is Support Vector Machine (SVM) model.***

KEYWORDS: Electricity Planning, Prediction Model, Support Vector Machine Model, Demand Prediction.

I. INTRODUCTION

Electricity-supply planning requires efficient management of existing power systems and optimization of the decisions concerning additional capacity. The deployment of smart meters is enabling the logging of huge amounts of data relating to the operations of utilities with the potential of being translated into valuable knowledge on the behavior of consumers. Demand prediction is an important aspect in the development of any model for electricity planning. The analysis of customer load profile and load estimation is an important and useful area of electricity distribution technology and management. There is constant need to improve the knowledge of load demands in electricity power stations and this requires for the collection and analysis of load profile information. The load forecasts help in determining which devices to operate in a given period, so as to minimize costs and secure demand even when local failures may occur in the system.

Data mining techniques are used on the determination of load profiles for different type of consumers considering the effect of weather conditions and other such factors. Statistical and clustering techniques are used on the determination of load profiles to support the development of tariff offer and market strategies. In our system we are trying to analyze particular household data so as to define its load profile based upon various factors and try to predict its future electricity usage so as to help the consumer conserve energy and help producer to meet demand side requirements and accordingly set tariffs.

II. MOTIVATION

The demand side management is quite crucial to handle due to different factors such as the size of the house, number of appliances being used, and type of consumers in the house based upon their age, income, financial status, and so on. There are frequent fluctuations in consumer usage of electricity based upon the above factors. Factors influencing such fluctuations can be age, income, usage pattern, etc. In the short run, the load is mainly influenced by meteorological conditions, seasonal effects (daily and weekly cycles, calendar holidays) and special events. Weather related variation is certainly critical in predicting electricity demand for lead times beyond a day ahead.

The main aim of this methodology is to enable utilities to benefit from the knowledge related to consumer segments and their dynamics while the penetration of smart meters is still low. Constant monitoring of the consumer load profile can help make a intelligent system to detect fluctuations and also predict future usage pattern.

Scope

1) Fetching records of energy consumed per minute of a large dataset.
2) Analysis of the data records and generate conclusion on the basis of attributes involving usage.
3) Fetching surveyed data and correlating it with the analyzed load profile data.
4) Predicting future power consumption and determining accuracy.
5) Detecting irregularities in load profile at any point of time.

III. LITERATURE SURVEY

In [1] the segmentation of electricity consumers and load clustering has been the focus. The usual stated applications range from the design and simulation of Demand side management i.e DSM strategies, load forecasting, tariff setting, and marketing and bad data detection.

In [2] clustering methods found to be used are mostly the K-means and the SOM algorithm. It also provides with a customer characterization framework. The data-mining model for consumer characterization is based on the combination of unsupervised and supervised learning techniques.

In [3] the use of static data related to household characteristics (e.g. income, inhabitants, education) and appliance use in relation to static or dynamic energy consumption data is being studied in order to find the main drivers of residential energy consumption.

In [4] the surveyed data and the metered data are correlated using probit regression. Segmentation helps divide the dataset into clusters using k means and further these clusters are related with surveyed data so as to determine the feature of the resultant system based upon the several factors related to household characters. Regression is a statistical method used to create a bond between such value datasets as described in this paper.

In [3] the prediction models are described along with their accuracy rate. Several prediction models are available lik GBT, Regression, SVM etc. Out of which SVM was found to have highest accuracy rate. In [5] SVM is studied to create prediction model of heavy datasets of commercial projects. [6] and [7] describes the complete theory behind SVM.

In [8] provides us the link for dataset chosen for our system, which is a French database of measurements of electric power consumption in one household with a one-minute sampling rate over a period of almost 4 years. Different electrical quantities and some sub-metering values are available.

IV. PROPOSED METHODOLOGY

The work flow diagram for the proposed system can be shown as follows:

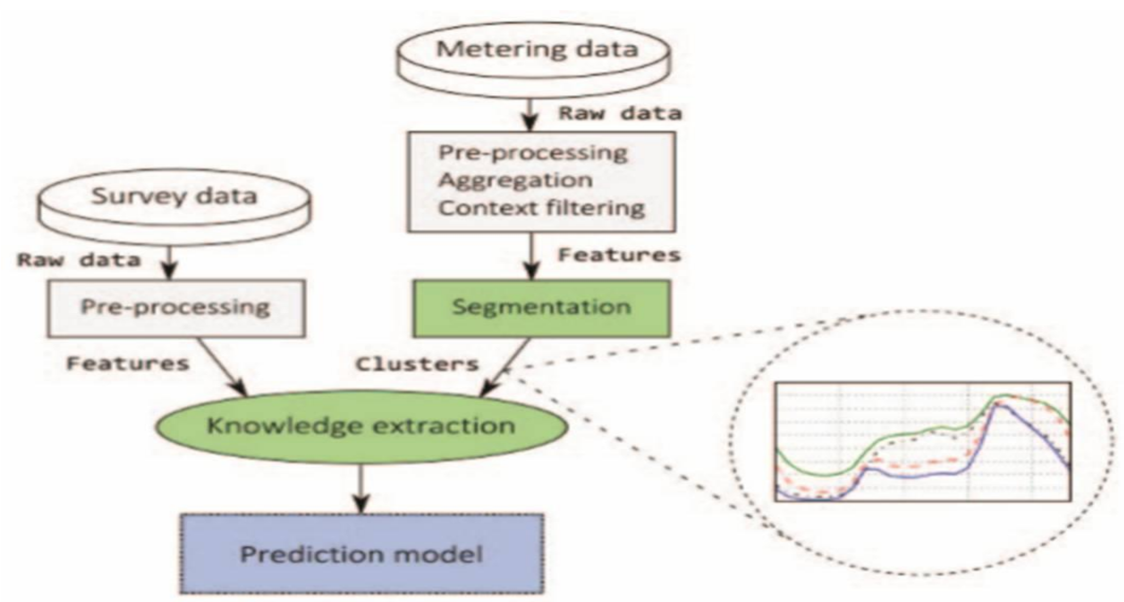

Fig1. Workflow diagram

According to the above work the dataset is collected in a interval of a minute using smart meters and is fed to the server. Preprocessing is carried out on the data and data is aggregated on hourly consumption. Segmentation can be performed for large datasets of multiple households and these household can be divided into clusters. Context filtering consists on selecting the date of a particular season, consumer group, time of day, voltage range etc from a large dataset. Further the households are surveyed and this data is correlated with the recorded metered data and knowledge extraction is performed. This knowledge is used and prediction model are applied on them.

Prediction model:

Predictive analytics encompasses a variety of statistical techniques from predictive modeling, machine learning, and data mining that analyze current and historical facts to make predictions about future or otherwise unknown events. Predictive analytics does not tell you what will happen in the future. It forecasts what might happen in the future with an acceptable level of reliability. The model which will be used is SVM model.

- **Support Vector Machine (SVM) Model:**

It is a newer and very popular classification method. It uses a nonlinear mapping to transform the original training data into a higher dimension. It searches for the optimal separating hyperplane (i.e., “decision boundary”) in the new dimension. SVM finds this hyperplane using support vectors (“essential” training records) and margins (defined by the support vectors). Vapnik and colleagues (1992) – Groundwork from Vapnik & Chervonenkis’ statistical learning introduced theory in 1960s. The training can be slow but accuracy is high. It has ability to model complex nonlinear decision boundaries (margin maximization). It is used both for classification and prediction. Some applications of SVM are handwritten digit recognition, object recognition, speaker identification, benchmarking time-series prediction tests etc.

Following diagram explains Support Vector machine and helps in getting support vector classifiers.

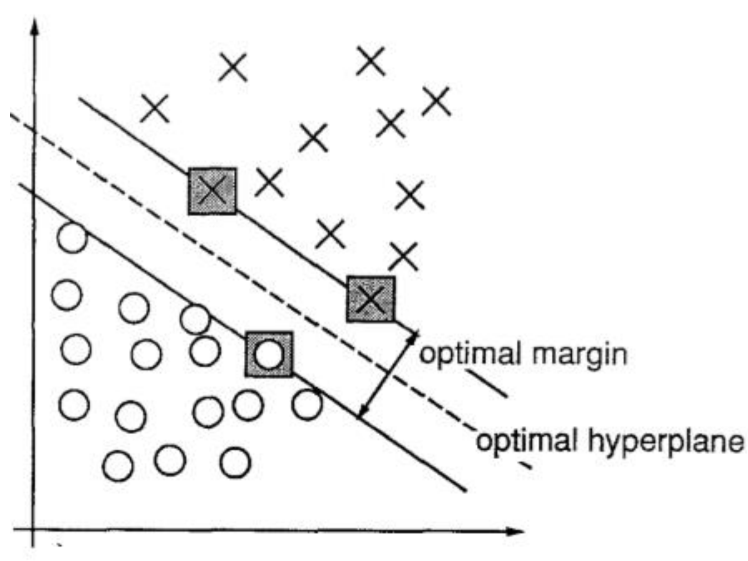

Fig.2 : An example of a separable problem in a 2 dimensional space for SVM

The support vectors, marked with grey squares, define the margin of largest separation between the two classes.

V. ARCHITECTURE OF PROPOSED METHODOLOGY

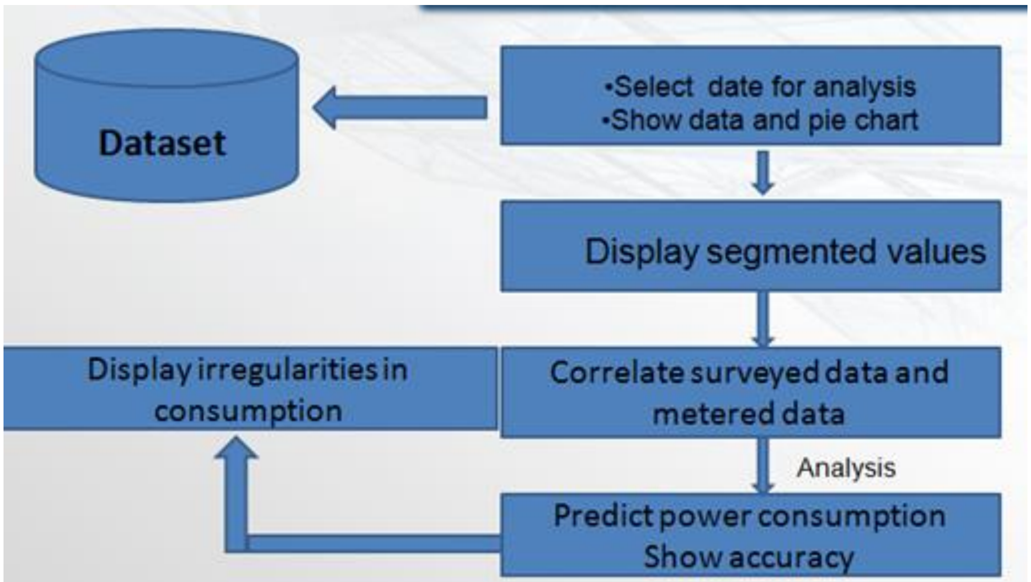

Fig.3: proposed work flow

Steps involved in proposed work:

Step 1: The metering data of the house is extracted and fed to the server.

Step 2: Pre- processing is carried out, hence removing missing values.

Step 3: The admin can log in into the system and can view data on the basis of various aspects.

Step 4: Admin can view aggregated data of :

a) Particular range of dates
b) Particular time of the day
c) Range of voltage i.e 220-260V
d) Range of active power
e) Range of reactive power
f) Particular season of a year

Step 5: Through analysis of this data the power consumption pattern of the consumer can be analyzed.

Step 6: Further survey data of household can be related with demand profile for knowledge extraction.

Step 7: Prediction model can be implemented on this knowledge to achieve future load profile pattern of particular household.

Step 8: Also the accuracy of the predicted load profile can be checked.

Step 9: Any abnormal changes/ irregularities can also be tracked if load profile exceeds certain voltage value.

VI. CONCLUSIONS

In this system an automated system is created which fetches and processes metering data continuously. Also pre-processing, aggregation and context filtering is achieved on the processed dataset. Depth analysis on the basis of various attributes is done. Pie chart representation of above attributes is done.

VII. FUTURE WORK

1. Extraction of surveyed data and applying probit regression to achieve factors having highest co-efficient.
2. Correlating surveyed data with metered data.
3. Prediction model is created for future prediction of energy consumption based on the correlation.
4. Tracking abnormal irregularities in voltage and designing an alert system for such fluctuations.

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