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Smart Meter Monitoring and Discovering Electricity Consumption Patterns using Big Data

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ABSTRACT: Since today`s digital energy meters have many drawbacks like real time monitoring, energy tampered, etc. to overcome these disadvantages we use smart meter to monitor energy consumption at domestic level. This helps in reducing energy consumptions and monitors the units consumed. The objective is to use the smart meter intelligent and provide comfort to consumer and to reduce power consumption.

This methodology use to extract electric energy consumption patterns in big data analysis in time series, so that very valuable conclusions can be made for user for monitoring and controlling electricity consumption. The methodology is based on the study of clustering validity indices in their parallelized versions along with the application of a clustering technique. It results in good resource utilization and load balancing of electricity usage.

KEYWORDS:Big data, smart electricity meter , electricity consumption pattern, clustering**.**

I. INTRODUCTION

Electricity is one of the vital requirements for sustainment of contents of life. It should be used very good judgement for its proper utilization. But in our country, we have lot of locality where we have supply for the electricity while many areas do not even have access to it.Our policies of its distribution are also partially responsible for this because we are still not able to correctly estimate our exact requirement and still power theft are existing [1]. On the other side consumers are also not satisfied with the services of electricity provider companies. Most of the time they have complaints regarding statistical errors in the monthly bills. with this we can monitor meter and track if any fault is there or not.

With the help of this project we are aiming to receive the monthly energy consumption from a remote location directly to centralised office. In this way we can reduce human efforts to record the meter readings are recorded by visiting every home individually.

The objective is to reduce power consumption, providing statistical data and to provide better service to consumer. The aim of this work is to discover electricity consumption patterns from big data time series. Due to the large size of the datasets, modern machine learning techniques based on distributed computing will be used to analyse the data [2].In this sense, we propose a methodology that optimizes the use of the parallelized version of k-means by studying several cluster validation indices , some of which are computationally designed to process big data

II. RELATED WORK

1. ***Design of an Automatic Meter Reading System:*** This paper describes the Automatic Meter Reading (AMR)system, an integrated and programmable meter reading and control system over existing telephone networks. The AMR system is automated, two-way system for remote reading and man- agement of utility meters. The automatic meter reading and management processes are free from human participation. Accuracy, speed, efficiency, and cost-effectiveness are the expected benefits achievable using the AMR system. The overall system is based upon the existing telephone networks;therefore, the service can reach anywhere there is a telephone[3]. All this is accomplished electronically and truly automatically, thus ending manual (and semi-automatic) meter reading and entry, call-backs, reading errors, and billing floats.

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2. ***SMS-based Reconfigurable Automatic Meter Reading System:*** Automatic Meter Reading (AMR) is not just replacement of manual meter reading with an automatic procedure, but has many advantages, some of which are listed below [1]. - Higher speed. - Improved load profile. - Automatic billing invoice. - Real time energy cost. - Load management. - Alarm warning. - Remote power switch on/off- Tamper detection. AMR is expected to be common in future. Nowadays, different AMR schemes are continuously evolving. Furthermore, integrating with the benefits of digital energy meters, contemporary AMR systems present more advanced and flexible features than their predecessors did in the past decades. Finally, thanks to the advent of new communication technologies, their competitive markets, and their ever- decreasing costs, the extinction of traditional meter reading system seems inevitable.
3. ***Electronic Energy Meter with Instant Billing:*** The importance of proposed work can be well understood if we keep in mind the amount of electricity being stolen every day. With heavy loads on the powerhouse one cannot track each and every household or commercial site. So to track any misuse at any stage of distribution we can use this method of billing. As a user can get the bill at any instant and can even pay it at any instant, so any kind of misuse by any other person can be avoided. An extensive amount of energy can be saved if we can track the misuse and the whole power problem can be dealt with by using this technique. The chances of tempering with this are very low. It checks the accuracy of utility billing charges consumption, demand and power factor[4]. It has a real time data display and access to metering equipment and usage data. So people at power house and the person who owns the equipment both can monitor the usage whenever they want to.
4. ***Data Collecting from Smart Meters in an Advanced Metering Infrastructure:*** The collecting data from energy meters, based on displacements of peoples, tends to be replaced by modern solutions: drive-by and Automated Meter Reading (AMR). Drive-by means that data are collected by mobile devices which pass near the meters. The personnel are considerably reduced and manually readings and records are eliminated. AMR use to automatically collect data from meters and send them to a central computer. The advantages of AMR are: reduced costs for meter readings, possibility to access meters otherwise difficult to attend because of their position or security reasons.It supports for real-time pricing, increased fraud detection, reduced read-to-bill time etc.

Table 1. Observation of Existing System

Characteristics	Observations
Meter billing and monitoring	We could able to monitor the energy requirements of each consumer with very small-time gap. With the easy governance we could able to be made decision for the next year power supply requirements according to that only we could able to give the information to generation units to avoid un-interrupted power supply[5].
keep the data in centralized database and generate the report	The purpose of this project is to develop a Smart Electricity meter using GSM. This can reduce human errors and helps to retrieve the real time meter value via GSM and send it to customers mobile phone through GSM[6].The administrator can analyse the customers power consumption and generate the online report from the data.
Internet of things (IoT)	We can see a person standing in front of our house from electricity board, whose duty is to read the energy meter and handover the bills to the owner of that house every month. This is nothing but meter reading. According to that reading we have to pay the bills.
Realtime and batch data ingestion	The system will implement two data absorption mechanisms, real-time and batch data ingestion. Real-time ingestion of information will integrate the data stream into the system directly from smart meters, which will provide near real-time systematic analysis of data results to customers

III. ARCHITECTURE OF SMART METER WORK

This section describes with the aim of finding patterns of electricity consumption in big data time series. In particular, this obtains electricity consumption patterns by studying the resulting clusters provided by the k-means included in the Machine Learning Library of Apache Spark The key steps of the proposed methodology for obtaining consumption patterns are shown in Figure 1

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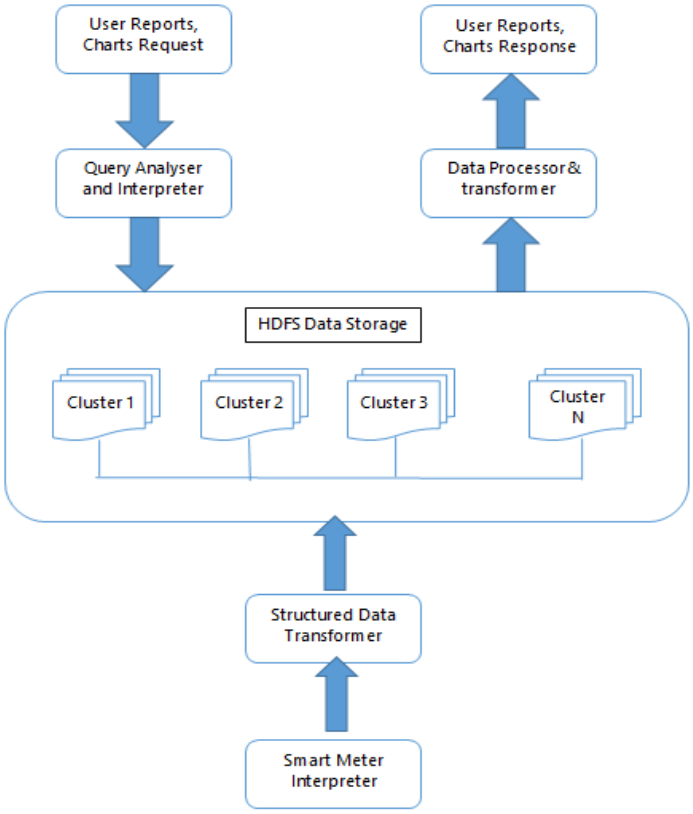

Fig.1 Architecture of Smart Meter Work

First Phase: Data Extraction and Transformation

In the first phase, data extraction and transformation process are going to perform. The objective of this phase to generate the data from Smart Meter and transform it into the structured data format. In the transformations in the original dataset to create an RDD variable, which can be distributed in a cluster and processed by Spark. The original dataset was obtained from the processing of several CSV,TSV files.

These files contained records in the form of time series of power consumption data from different users present into the area. Data will be extracted from the smart meters to analyse further. The smart meters collected electricity consumption records in interval of every 5 minutes.

Each row of the starting RDD variable is composed below information

1) UserID of customer
2) UserName of the customer
3) Full address of the customer
4) Date and Time
5) Units Consumed in last 5 minutes
6) Smart Meter Unit Reading

Second Phase: Data Storage

The second phase consists of data storage for the data generated from first phase in the clustered format. In this, we can store the data based on the region/city/area and also based on the number of users present into that region. The replication factor provides the high availability and consistency to the system. Due to which failure in the 1 or more clusters can be overcome by using replicated copy of the data. Hadoop Distributed File System (HDFS) is used to store the data into the clustered format[7]. This phase is interlayer between the First Phase i.e. Data Extraction and Transformation and Phase Third i.e. Data Analyser.

Third phase: Data Analyser

The last phase consists of two parts. Query Input requested by user and processed output from the system. The request provided by the user is analyse and interpreted by the Apache Spark, which provide request for desired output from HDFS system. HDFS process the data and provide the raw data as output. This raw data will get processed and

transformed based on the requested charts/report format data. On Graphana, data will get shown in reports/charts format.

IV. SIMULATION RESULTS

A. *Various Standard Security Solution*

Increase of the usage of manual reading causes faulty and higher electricity bills. Detecting power consumption patterns can be used to monitor and minimize the electricity bill. The pattern analysis is use for better performance in real time to detect devices and record the power consumption of each device to get a detailed power consumption data set for better analysis. By examine this data set, the device is identified and then the classifications are done to detect patterns of device usage, which provide means to optimize the device handling to minimize the power consumption[8]. As the security industries response to these challenges, a new generation of security analytics solutions has emerged in recent years, which are able to collect, store and analyze huge amounts of security information across the whole enterprise in real time.

B. *Energy monitoring charts and tables*

Energy monitoring charts and tables can be used for many kinds of electricity consumption analysis. They are particularly useful for the energy monitoring and targeting practiced by energy consultants and energy managers or facility managers[9]. The "Daily" feature can be very useful for getting a quick and accurate detailed snapshot of energy consumption over a longer period of time. This is great for pinpointing days when energy consumption was uncommonly high or low between your chosen times (you can use midnight to midnight if you want to look at complete days).

The "Single Day" feature allows you to view an individual date in more detail as shown in Fig.2;Just like with the "Calendar" charts, you can easily leave out the average, maximum, and minimum overlayed comparison data if you want your single-day charts to be as simple as possible[10]. The "Single Day" feature help you identify dates of interest such as:

- The date of maximum consumption.
- Dates where consumption was above or below a certain threshold.

As shown in Fig.3 When tracking energy performance, it's very important the "Weekly" and "Monthly" features make it easy to do this. Although you can use the "Weekly" and "Monthly" features to look at overall changes, it's usually better to focus in on specific days-of-the-week and times-of-the-day

As shown in Fig4."Comparision between Weeks" features give you the option of looking at maximum and minimum power demand. This can be useful for comparing the average, worst, and best energy performance according to weekly electricity consumption[11]. The data in this chart specifically removes the energy consumption on holiday days when the business was closed. This data will not allow the average and minimum values from being affected by the low energy consumption on holiday days.

As shown in Fig5.The pie chart illustrates about the proportion of an energy consumed by different district and the details about amount of electricity used in Maharashtra state. In conclusion, the more developed and populated cities consumed electricity most, and also more people in city will use more electricity[11].

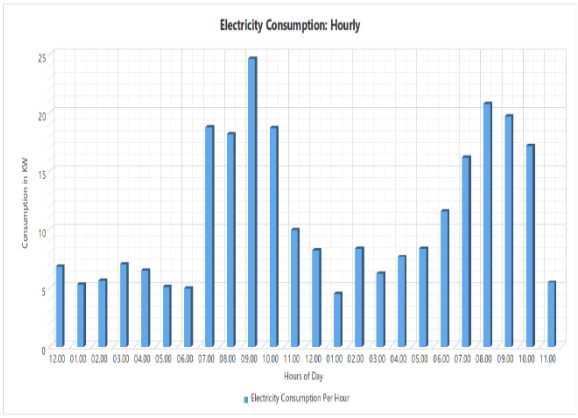

Fig.2 Electricity consumption per hour

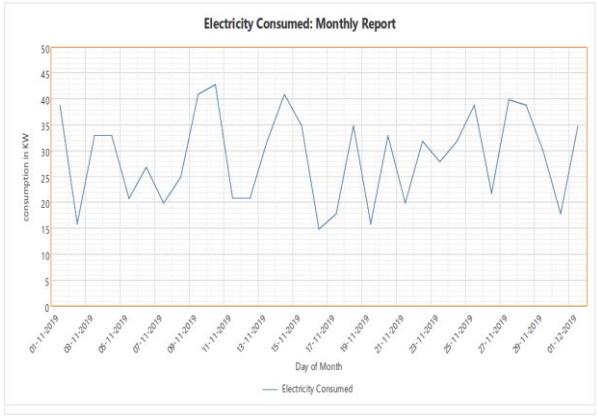

Fig.3 Monthly Electricity consumption

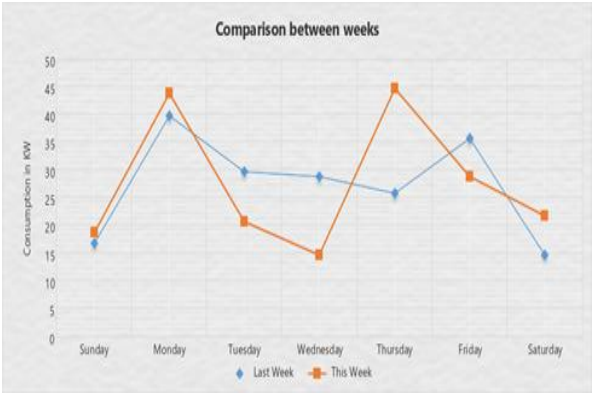

Fig.4Comparison between different weeks

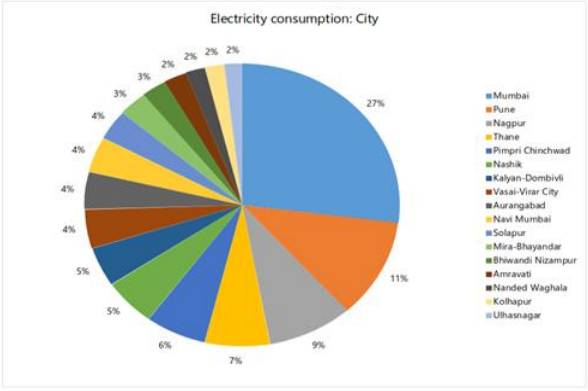

Fig.5 Electricity consumption in cities of Maharashtra

V. CONCLUSION AND FUTURE WORK

Since today`s energy meters have many drawbacks like real time monitoring, energy tampered, etc. to overcome these disadvantages we use smart meter to monitor energy consumption at domestic level. This helps in reducing energy consumptions and monitors the units consumed. The objective is to make the use of smart meter intelligent and provide comfort to consumer and to reduce power consumption.

This methodology use to extract electric energy consumption patterns in big data analysis, so that very valuable conclusions can be made for customer for monitoring and controlling the use of electricity. The methodology is based on the study of clustering validity indices in their parallelized versions along with the application of a clustering technique.

In this work, we analysed and interpreted different sets of consumption data of various households and their daily behaviour patterns are graphed. Thatanalyze the data on an hourly basis to understand the potential that much line grained measurements can have on control of electricity consumption also understand how to move demands in time so that the overall power consumption becomes less varying and costly. This change people ‘s mind a bit more intelligent during the day for better distribution of energy consumption. Customer can utilize resources efficiently. It results in good resource utilization and load balancing of electricity usage.

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BIOGRAPHY

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