DEVELOPMENT OF DATA ANALYTICAL ALGORITHM FOR SMART METER READING

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Abstract – Measurement is one of the first step towards effective energy management and refining customer behaviors. Smart meter enables understandability for client to screen use and take part popular reaction and vitality transformation. In the service provider end, utilities can dynamically monitor and price electricity consumption. Thus supporting a range of time tariffs. In this paper, we illustrate one such method of metering and mechanism involved in calculating differential metering technique. The differential pricing algorithm proposed here involves a combination of peak hour tariff and traditional traffic, that is as number units consumption increases peak hour tariff and normal tariff will be set to higher value. We have provided a GUI where customer can monitor the usage analytics in real time and plan accordingly. The online bill generation and payment is also provided which makes the entire process simpler than how it was carried out before. The GUI at service provider end let them visualize the usage statistics per area/ city/ user. The pricing for peak hour and normal hours can also be changed by authorized service provider. As a whole it makes the metering process a lot easier and simpler.

Key Words: **Smart meter, Electricity consumption, Tariff, Peak hour, Analytics, Usage statistics**

1. INTRODUCTION

A smart meter is an electronic device which is used to record the energy consumed by the household or industry at a very fine regular interval of time. Smart meters have paved a way for energy management systems and analytics system which has made the lives easier. Smart meters generate large amounts of fine-grained data that provides useful information to consumers and service providers for analysis. This paper describes the smart meter analytics system which takes in the real time data generated by the smart meter to store it in a database for testing and verification. [1]

The database is mined for data and analytical algorithm is applied on it for generating a peak hour analysis for each users and city-wise statistics for the service providers. The analytics is shown on a web application which provides separate interface for users and the service providers.

This paper also describes about the visualization techniques used for showcasing the results. Since the data generated by the meter is real and dynamic in nature, we use D3.js which is a JavaScript library for producing dynamic, interactive data in web browsers. It makes use of the widely implemented SVG, HTML5, and CSS standards. [3]

2. Related Works

The existing system for metering in India is either an

electro-mechanical meter or a digital meter which gives only initial and final readings of meter. The service providers need to send an authorized personal to each individual house for reading meters and providing them bill. [2]. The disadvantage of these devices are that the user have no idea on how much energy units are they consuming the energy based on the time on daily basis, they also need to pay their bills in the office.

Currently the data about the usage of electricity is stored in the meters itself, they have small amount of memory in them which will store the number of units used by the user. Earlier days, it was done through mechanically driven gear system where a ring used to run around, driving the shaft of gear which used to control the number of units used.

In India, most people do not have the knowledge of the analysis of the electric metering. It is observed through a random survey of around 500 consumers that residential consumers are really not aware of the pattern of usage of their electrical consumption and just have a postmortem analysis once they get their electricity bills from the service providers.

In the present day metering system, we do not get any kinds of analysis on our usage, people don't get to know peak hour analysis, pattern on how they have used the electricity. The system only provides the number of units used and doesn't even show the tariff details.

3. SYSTEM OVERVIEW

The system consists of 4 sections:

I. Data generation
II. Data storage
III. Data analysis
IV. Data visualization

Data generation: Data required by the system is the amount of the energy consumed by each individual user, this task is completed by the smart meter which records the units of energy used and store it locally. Initially during an hour the units consumed by the user is recorded in the meter itself, later every minute data is pushed onto the database which is used for analysis.

Data storage: MySQL is the most popular Open Source Relational SQL database management system. MySQL is one of the best RDBMS being used for developing web-based software applications. As a database server, its primary functions are to store data securely and return that data in response to requests from other software applications. We are using MySQL for our data storage system since it supports extra features of extensibility. The data generated in the meter is sent here for storage, the data is stored as per the following schema:

Admin side- table in the admin side contains the username, password, tariff for peak and normal hours.

User side-table in the user side contains username, password, email-id, meter-id, peak hour details, tariff details and bill.

The relationship between the admin entity and users are 1-N relationship, which says that there will be one admin who will do the analysis for N number of users. Admin might be the service providers themselves and the users are the customers.

Data analyzation: Once the data is stored in database, it is analysed to get results out of it. The analysation technique used is a separate algorithms for admin statistics and for user statistics.

The algorithm used for the user stats is described as follows:

Algorithm

1. **for** each consumer locally a 60 slots array(a[60]) is used to store the power consumption of each minute.

a[1] -> 1st minute power consumption
a[2] -> 2nd minute power consumption
.a[60] -> 60th minute power consumption

2. As all the slots are occupied in an hour, then its total power consumption is calculated locally and updated to database
   Total power consumption = a[1] + a[2] + ... + a[60]
3. Thereafter as each min passes just like sliding window concept, initial minute power consumption is subtracted from total consumption and new minute power consumption is added
   New total power consumption = old total p c - a[1] + new min p c
4. This newly generated power consumption is update to user table ,
5. Repeat from step 2, each minute there after throughout the day.

The algorithm for the admin stats is described as:

To find the peak hour of each user: at the end of the day, entire data set of each user is extracted from database to calculate his peak hour of that day

Entire data set = 1+(23*60) = 1381 values indexed from 0 to 1380

Initially assume max power consumption off the day is 0

maxPower = 0

With the of linear search algorithm compare max with each data set

for(i=0 ;i<= 1380 ; i++)

if max < ith power consumption

then max = ith power consumption

and time index = i

max contains maximum power consumption of that day

Now to convert time index to time format

hour = time index / 60

minute = time index % 60

So peak hour of the particular user is from hour : minute - hour + 1 : minute

Above algorithm is implemented to all the users with help of multi-threading to achieve efficiency

Data visualization: Data Visualization is an important aspect for direct customer monitoring of power usage trends and controlling it. It is done using D3.js, a JavaScript library for manipulating documents based on data. The input to D3 is in the form of a .csv file containing the Time stamped power usage values obtained from the database.

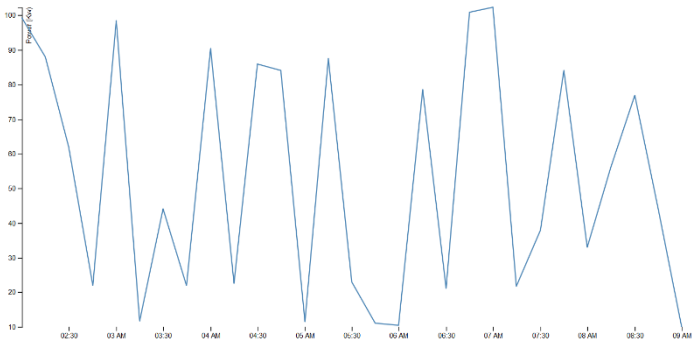

Fig 1-Result of analysis

4. CONCLUSION

The analytical system developed will give a detailed usage analysis to the user along with the tariff details and a billing section. It also eliminates the need for service providers to go to each house for billing, they also can save energy based on the city analysis. Overall the system makes the lives smarter

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