Discovering Human Activity Patterns Using Smart Meter Data

DS Bhupal Naik, D. Venkatesulu, V Ramakrishna Sajja, A Sridevi

ABSTRACT--- Population lived in rural zone contributes to 68% and urban zones contribute to 32% of the total world population. According to 1995 census, the proportion of rural to urban population of the world was 55% and 45% respectively. By 2025, the increase in the urban population (59%) ratio would be drastic raise to the rural population (41%). The statistics shows that, most of the citizens are moving from rural to urban areas and habituated to the smart technology and least bother about their health. Health care services are a standout amongst the most difficult viewpoints that is extraordinarily influenced by the colossal surge of individuals to city culture. Consequently, urban communities around the globe are putting vigorously in advanced change with an end goal to give more advantageous to individuals. In such a change, a huge number of homes are being furnished with smart gadgets (e.g., smart meters, sensors, etc.,). A well-being health care application is proposed using smart meter data for discovering human activity patterns. A frequent pattern growth algorithm, K-means algorithm and Network aggregator is used to measure and analyze the energy usage by occupants' behaviour.

Keywords: Smart Meter, Smart technology, FP Growth, K Means, Network aggregator, Healthcare application.

1. INTRODUCTION:

According to the survey by 2050, digital transformation plays an integral role. Most of the houses are equipped Smart meter, smart technology, clustering, aggregators, FP growth with the smart devices like smart TV, Oven, Smart light, AC, smart meters etc., According to the Economic Cooperation and Development most of the IoT devices are used by the Koreans, Danish, and Swiss people [8].Thus far, most IoT activities in health services spun around the enhancement of consideration in that capacity with remote monitoring and telemonitoring as primary applications. A second territory where numerous activities exist is tracking, monitoring and support of assets, utilizing IoT and RFID. This is done on the dimension of therapeutic gadgets and social insurance resources [7].The IOT plays an important role in healthcare. By using the IoT devices, we can predict the human health conditions by using the sensor data. IoT clears different methodologies in health researches. At the side of, data analytics will turn out to be much durable [9].

Now a day's, most of the people are using the smart technology which is making health dangerous. If they get any health issues, they approach the hospital and doctors will undergo the investigation process by asking few simple questions. If the disease is identified by the doctors, the treatment is advised. This whole process is done in some countries.

But in some countries, if the disease is not identified, the doctor or his assistant goes to the patient house and observe each and every device and patient behaviour. The doctor or his assistant takes the smart meter data and they analyse the meter data. They check each and every appliance utilisation and the time they spent and at what time they are utilising the appliance. For example, if the person is watching the Television during night but the patient or his family members not using the light at the same time. By analyzing this data, the doctor will predict that they have some eye contact problem or in n near future, they can get the eye contact problem.

By analyzing the smart meter data, the patient mentality and their behaviour in the house can be identified. In recent years, most of the doctors are following this kind of treatment because some diseases are unpredictable. We can also diagnose the Psychological related problems by using the smart meter data. For example, if a micro oven appliance is used in the afternoon daily for heating the food items. But, on one day, the oven was used continuously for about 60 minutes which indicates that the person may have some psychological problem.

Power consumption and the period of utilization are closely related to the resident's activities performed at household. For example, if the oven is in on mode, the task of this apparatus is generally expected with preparing food. The time (e.g. morning or night) of this movement may likewise demonstrate the type of food being arranged, such as breakfast or supper. Moreover, individuals frequently perform more than one action in the meantime, for example, setting up their very own food and listening to music or watching programs over Television, which implies numerous apparatuses are operated together [1].

2. RELATED WORK:

Yassine, A,. et al[1] proposed a model to identify the health condition of the people using the smart meter. Here FP- growth algorithm-means clustering algorithm and Bayesian network algorithms are used to identify the health condition and prediction of the diseases.

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Liao, J,. et al[2] discussed about a model for distinguishing local household activities from savvy meter total information. Here two types of activities are identified type-1is recognising activities using the smart meter data and in second type, the temperature and humidity activity is recognised using NALM and disaggregation algorithms.

Alam, M [4] proposed a model for abnormality people who are living single in the home. A wearable sensor data is collected and MGMM algorithm (Maximum Gaussian Mixture Model) applied.

Gajowniczek, K [5] modelled to find the structure of home machines usage patterns, henceforth giving more knowledge in savvy metering frameworks by considering the utilization of selected home appliances and the time of their usage. An unsupervised machine learning algorithm was used.

Yassine, A [6] tackles the issue of access control by reasonably remunerating purchasers for their interests in the information advertise in view of the idea of differential security. The consequences of the examinations demonstrate the significance of taking purchasers' states of mind towards protection as an urgent component in planning adjusted markets for reasonable information sharing. The further sections of the paper are organized as follows: Section 3 focuses on the proposed system design. in section 4, The experimental results are discussed and Conclusion and Future work is discussed in section 5.

3. PROPOSED SYSTEM:

A smart home equipped with smart devices from which the data is collected by the smart meter placed in the smart home. Now the smart meter data is stored in various forms of databases. The smart meter data from the database is taken for pre processing in which the noisy and inconsistent data is cleaned. Then, the preprocessed data is submitted to the k-means clustering algorithm which clusters the data with similar patterns into one cluster. Then, FP (Frequent Pattern) Growth mining is used on the clustered data for generating the association rules for finding the behavior patterns between the appliances to appliances i.e., which appliances are operating together.

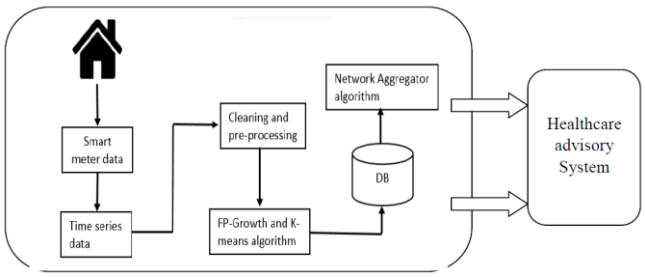

Fig. 1: proposed architecture

3.1 Pre-processing:

The dataset used is a compilation of smart meter data from five diverse houses in the United Kingdom (UK) [1][3] which have above 400 million raw records. For this data we apply the cleaning and preparation the data is reduced to 20 million records. Additionally, we generate the synthetic data for observing the model[1]. After the pre-processing step we apply the dataset to the algorithms.

3.2 FP-growth algorithm:

FP-growth algorithm is used for the appliance to appliance usage identification. The Activity identification, such as ‘‘watching TV, Cooking, Using Computer, Preparing Food and Cleaning Dishes or Clothes’’ are usually regular routines [1]. If two appliances are using at a time means they are doing multiple jobs for example if the person operates the washing machine and at the same time operates the oven and TV by that we can say that the person is entertaining and doing the house work.

3.3 K-means clustering:

K-Means clustering algorithm [10] is a Partitioning based clustering algorithm which is used to group the similar elements into one cluster. It is also used for appliance to time association. Appliance-to-time associations are underlying information in the smart meter time series data which include sufficiently close time-stamps, when relevant appliance has been recorded as active or operational [1]. For example, if the user uses the Thermostat continuously that means they are using the thermostat from morning to evening they can get skin related problems. If the user uses the Crock pot at afternoon and evening by we say that they does not have any obesity problems. The Crockpot mainly used for preparing for non-oily food.

3.4 Network aggregator:

The network aggregator is mainly used for 2 reasons one is for prediction of the health condition and another one is to reduce the processing time. The smart meter data means it has large amount of data to process. In the existing system map reduce is used for processing the data and for the prediction Bayesian network is used. But in this paper we use network aggregator for both purposes. For optimizing the big data processing aspect in prior model we propose to use network aggregators for processing of each appliance unit information.

In the map reduce the mapper should perform 7 tasks they are reducer analysis , workload analysis, workload partitions , reducer sharing ,work load assignments to reducer, Merging selective outputs of reducer ,Merging selective outputs of all mappers. By performing all these tasks the processing time is increased, for that to reduce the processing time network aggregator is assigned to the mapper. For each mapper we use to aggregators.

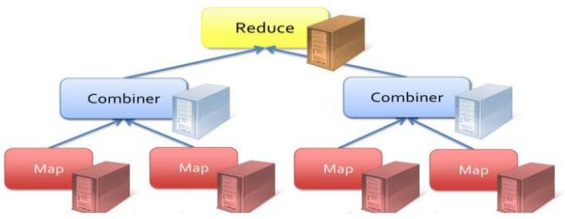

Fig. 2: Network aggregators

Network Aggregators describes a style of communication models where the request for a given transaction is initiated by the source (Mapper) and the transaction is handled and

managed by a series of multiple aggregators to reduce processing complexity especially with respect to I/O operations.

4. RESULTS:

This paper is totally divided into 3 parts first one is smart home analysis second one is human activity patterns using Bayesian network and third one is human activity prediction using the network aggregator.

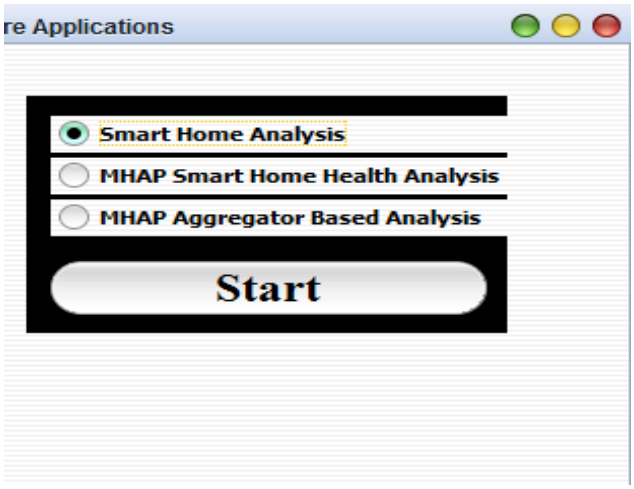

Fig. 3: Home page

At first we create a smart home using the smart IoT devices using network programming simulator. By using that we create a smart home and shown that what type of applications are using most of the people in the house.

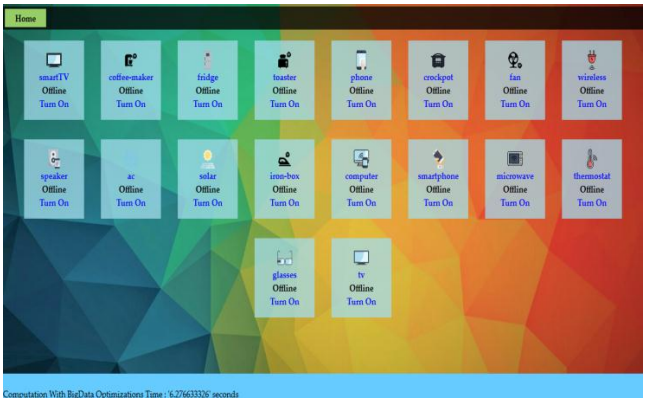

Fig. 4: smart home analysis

Here we saw that every device is in the offline when we click on the start trace simulation the devices will automatically come in to the online mode. For every 30 seconds the devices will be updated and shown how much of the electricity they consumed.

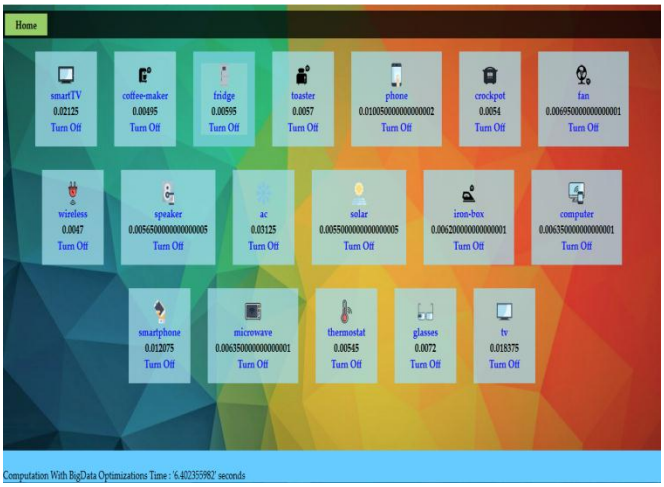

Fig. 5: After updating the IOT device and their utilising cost

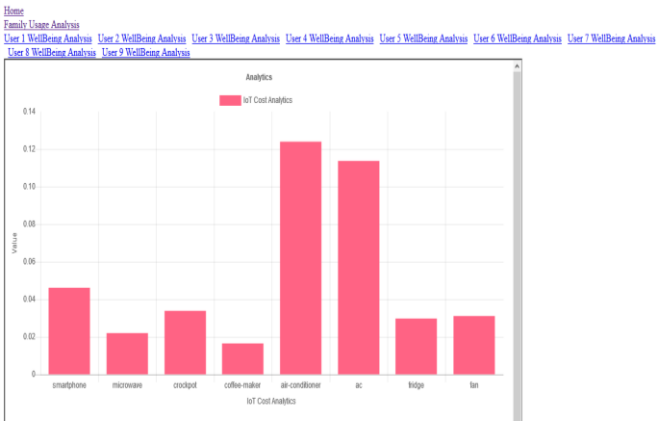

Fig 6: Bar graph for human activity patterns using the Bayesian network

This graph shows how much of appliance is used mostly by the people in the house. In the house mostly used air conditioner and portable AC and smart phone is mainly used.

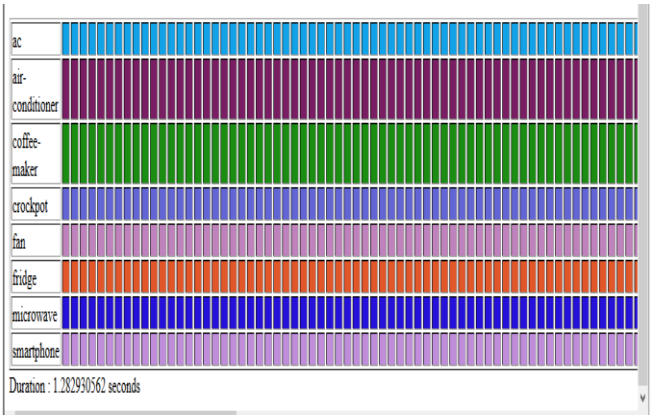

Fig. 7: Heat map analysis of the appliance usage

By using the Bayesian network it takes 1.2829 seconds to process the data. Bayesian network is mainly used for the prediction of the health condition of the patient.

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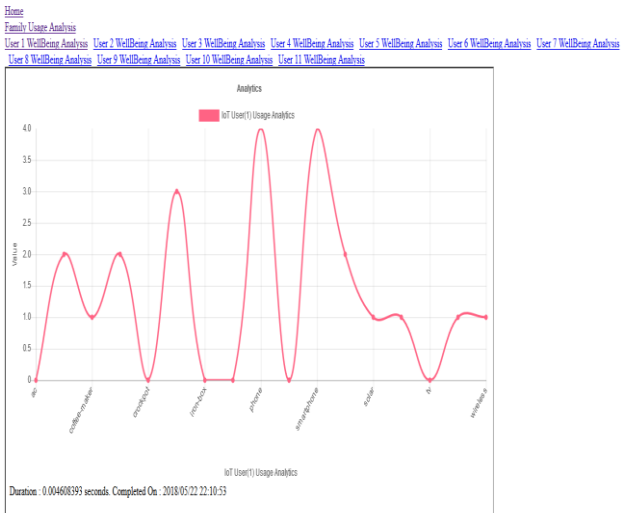

Fig. 8: Curve graph for human activity patterns using network aggregators

By using the network aggregator algorithm the processing time takes 0.004608 milliseconds to process the data. The network aggregator is used for both activity prediction and to reduce the processing time.

5. CONCLUSION AND FUTURE WORK:

We presented activity recognising and health prediction using the network aggregator and also reduce the processing time. Here each and every appliance usage is identified and on the basis of time. In this paper the total system is based on the time only. We take the data also time series data. By using the time only we observe the appliance usage. At what time the two appliances is used at a time and at what time the single appliance is used .And how much time it is used.

In the future we are planning to develop well-being applications to promptly take activities, for example, sending caution to patients or care takers, Moreover, we are intending to assemble a wellbeing model to naturally discovered appliances to potential activities. This implies we can efficiently prepare the framework and increment the accuracy of identifying human activity.

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