Healthcare Analysis using Smart Meter Data

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Abstract— As we know that, there is a rapid raise in the count of the population relocating to urban areas. Health care services is one of the most challenging features that is greatly affected by the vast inrush of people to city centres. Cities are currently adopting massive digital transformation in an effort and support to provide a healthier environment. Most of homes are being furnished with smart devices (e.g. smart meters, sensors etc.) which generate massive volumes of fine-grained and indexical data that can be analysed to support smart city services. This paper proposes a model that exploits smart home big data in order to analyse and discover the changes in energy usage in house holder's behaviour for health care application to detect health problems. Here we used cluster analysis, frequent pattern and prediction process. Since people's habits are mostly identified by everyday routines, evaluating these routines makes us to recognise abnormal activities that may indicate people's difficulties in taking care for themselves, such as not preparing food or not using shower/bath. The human activity datasets which are generated by the smart meters are mined using the Big Data algorithms. The results of identifying human activity patterns from appliance usage are presented in details in this paper along with accuracy of short and long term predictions.

Keywords: Big Data, Smart Home, Smart Meters, Smart City, Frequent Pattern Mining, Cluster Analysis, Prediction, Health Care Applications

I. INTRODUCTION

Over the last decade, there has been a growing interest in the development of smart environments which are able to reason about their residents. A smart environment is defined as one that is able to acquire and apply knowledge about an environment, such as a home, and adapt to its inhabitants to improve their experience in that environment. A Healthcare service is one of the gut most challenging aspects that is greatly needed in many of the emergency situations which will be helpful for old age people and people who stay back at home. Every day human metabolism changes according to their daily work or activities. User habits are mostly correlated with everyday routines. Homes are being furnished with smart devices (e.g., smart meters, sensors, and so on) which generate massive volumes of numerical data such as current readings in electricity board that can be analysed. Since all the habits are mostly identified by everyday routines, discovering these routines allow us to recognise anomalous activities. This system analyses the energy consumption patterns using Hadoop MapReduce algorithm with the help of appliance usage data at smart homes, which is directly related to human activities. The ability to perform ADLs independently and completely on a regular basis provides measurement of the functional status of residents if they want to live independently in their own homes. Moreover, such systems can provide timely prompts to the residents in case they have forgotten to perform critical activities.

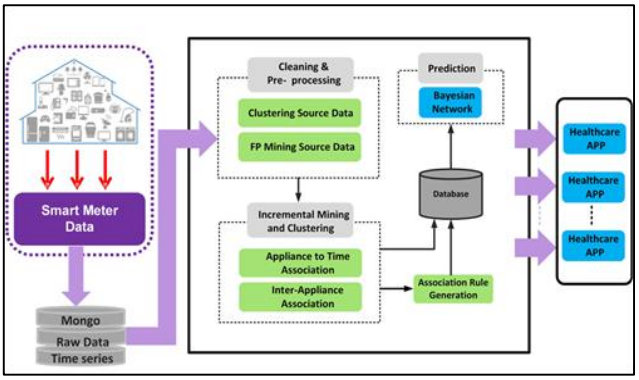

Fig. 1: Architecture for health analysis using smart meter data

There is 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 like Mongo, Raw data and Time series. The Mongo database is a flexible and scalable document database. The data can also be stored in the raw data form without any transformation for the data. The time series database stores sequences of values or events obtained over repeated measurements of time (e.g., hourly, daily, weekly).The smart meter data from the database is taken for performing various processes. First it starts by cleaning which the noises and inconsistent data are removed. Then clustering of the source data occurs which the data having similar properties are grouped into classes of data called clusters. Next FP (Frequent Pattern) mining of the source data occurs. It is process of finding frequently occurring patterns in the source data. Through FP mining, the appliance to appliance association can be obtained i.e. which appliances are operating together. Next phase is incremental mining and clustering. The incremental mining is a form of mining which maintains the already discovered patterns with the existing patterns and newly discovered patterns whenever database gets updated. Then clustering happens to find the appliance to time association details i.e. which appliances are operating at what time. These associations are stored in the database. Then an inter appliance association can be inferred which helps to generate association rules among appliances. These association rules are a form of representing frequently associated patterns. The association rules are stored in the database. From the database the appliance to time associations as well as the association rules are taken up by a graphical probabilistic model called Bayesian network. This is a directed acyclic graph which consists of nodes and edges.

The nodes represent random variables and edges represent probabilistic dependency. This network is used for prediction process which is a data analysis method. The process predicts the human activities inside the smart home. These activities are learned by specific health care application

to detect the health problems in order to provide specific health care to the specific user.

II. LITERATURE REVIEW

Literature survey is the most important step in software development process. Before developing the tool it is necessary to determine the time factor, economy n company strength. Once these things r satisfied, ten next steps are to determine which operating system and language can be used for developing the tool. Once the programmers start building the tool the programmers need lot of external support. This support can be obtained from senior programmers, from book or from websites. Before building the system the above consideration are taken into account for developing the proposed system.

A. Abdulsalam Yassine

Investigated there is an ever-increasing migration of people to urban areas. Health care services is one of the most challenging aspects that is greatly affected by the vast influx of people to city centers. Consequently, cities around the world are investing heavily in digital transformation in an effort to provide healthier ecosystem for people. In such transformation, millions of homes are being equipped with smart devices (e.g. smart meters, sensors etc.) which generate massive volumes of fine-grained and indexical data that can be analyzed to support smart city services. In this paper, we propose a model that utilizes smart home big data as a means of learning and discovering human activity patterns for health care applications. We propose the use of frequent pattern mining, cluster analysis and prediction to measure and analyze energy usage changes sparked by occupants' behavior. Since people's habits are mostly identified by everyday routines, discovering these routines allows us to recognize anomalous activities that may indicate people's difficulties in taking care for themselves, such as not preparing food or not using shower/bath. Our work addresses the need to analyze temporal energy consumption patterns at the appliance level, which is directly related to human activities. For the evaluation of the proposed mechanism, this research uses the UK Domestic Appliance Level Electricity dataset (UK-Dale) - time series data of power consumption collected from 2012 to 2015 with time resolution of six seconds for five houses with 109 appliances from Southern England. The data from smart meters are recursively mined in the quantum/data slice of 24 hours, and the results are maintained across successive mining exercises. The results of identifying human activity patterns from appliance usage are presented in details in this paper along with accuracy of short and long term predictions.

B. Dr. V. Karpagam

Investigated Healthcare service is one of the most challenging aspects that is greatly affected by the migration of people to city centres. Cities are currently embracing massive digital transformation in an effort to support and provide a healthier environment. In such transformation millions of homes are being equipped with smart devices eg.smart meters, sensors etc which generate large volumes of data that can be analyzed to support health care services. The challenge is how to mine complex interdependencies among different appliances usage within a home where multiple data streams are occurring. The main goal is to discover human behavioural characteristics as an approach to understand and predict their activities that could indicate health issues. The human activity datasets which are generated by the smart meters are mined using the Big Data algorithms. If there is no usage of any appliances the result is given as an input to the health care application for further alerting needs.

C. Ehsan Nazerfard

Investigated In spite of the significant work that has been done to discover and recognize activities in the smart home re- search, less attention has been paid to predict the future activities that the resident is likely to perform. An ac- tivity prediction module can play a major role in design of a smart home. For instance, by taking advantage of an activity prediction module, a smart home can learn context-aware rules to prompt individuals to initiate im- portant activities. In this paper, we propose an activity prediction approach using Bayesian networks. We pro- pose a novel two-step inference process to predict the next activity features and then to predict the next activ ity label. We also propose an approach to predict the start time of the next activity which is based on model- ing the relative start time of the predicted activity using the continuous normal distribution and outlier detection. We evaluate our proposed models using real data col- lected from two smart home apartments.

D. Sreelekshmi.U, Gopu Darsan

Investigated there is an increase in the number of people migrating to urban places. So the need for health care resources is greatly affected by this vast influx of people moving to cities. As a result cities around the world are heavily investing in digital transformation in order to provide healthier ecosystem. In such a transformation millions of homes will be utilizing smart devices like smart meters, smart sensors and so on which can generate massive amount of data which can be used to support smart city services. This paper proposes a model that utilizes smart home big data in order to learn & discover human activity patterns for health care applications to detect health problems. The proposed model uses frequent pattern mining, cluster analysis and prediction processes. Since there is a strong relation between people's habits and every day activities, discovering these activities enable us to identify anomalous activities that may indicate people's difficulties such as not preparing food or not taking bath. This paper analyses temporal energy consumption patterns at the appliance level which can be directly related to human activities.

The applications arise in the field of tracking individuals living alone or persons with self-limiting conditions. mining and clustering. The incremental mining is a form of mining which maintains the already discovered patterns with the existing patterns and newly discovered patterns whenever database gets updated. Then clustering happens to find the appliance to time association details i.e. which appliances are operating at what time. These associations are stored in the database. Then an inter appliance association can be inferred which helps to generate association rules among appliances.

These association rules are a form of representing frequently associated patterns. The association rules are stored in the database. From the database the appliance to time associations as well as the association rules are taken up by a graphical probabilistic model called Bayesian network. This is a directed acyclic graph which consists of nodes and edges.

The nodes represent random variables and edges represent probabilistic dependency. This network is used for prediction process which is a data analysis method. The process predicts the human activities inside the smart home. These activities are learned by specific health care application to detect the health problems in order to provide specific health care to the specific user.

III. EXISTING SYSTEM

Detecting human activities in smart homes by means of analyzing smart meters data is studied. The paper proposes two approaches to analyze and detect user's routines. One approach uses Semi-Markov-Model (SMM) for data training and detecting individual habits and the other approach introduces impulse based method to detect Activity in Daily Living (ADL) which focuses on temporal analysis of activities that happen simultaneously. Similarly, the work proposes human activity detection for wellness monitoring of elderly people using classification of sensors related to the main activities in the smart home. Smart meters data are also used for activity recognition using Non-intrusive Appliance Load Monitoring(NALM) and Dempster- Shafer (D-S) theory of evidence. The study collects pre-processed data from homes to determine the electrical appliance usage patterns and then employs machine learning-based algorithm to isolate the major activities inside the home. The issue is that the study has to perform two steps on the data to completely isolate the main activities.

IV. PROPOSED SYSTEM

The proposed model it starts by cleaning and preparing the data and then applying frequent pattern mining for discovering appliance-to-appliance associations, i.e., determining which appliances are operating together. Then, it uses cluster analysis to determine appliance to-time associations. With these two processes, the system is able to extract the pattern of appliance usage which is then used as input to the Bayesian network for short-term and long-term activities prediction. The output of the system is utilized by specific health care applications depending on the intended use. For example, a health care provider might only interested in knowing activities related to cognitive impairment where tracking the sequence of daily activities is crucial for reminding the patient when abnormal behavior is detected.

V. MODULE IMPLEMENTATION

A. Cleaning and Preprocessing

The issue is that the study has to perform two steps on the data to completely isolate the main activities. Exploiting appliance usage patterns and identify them for sudden behavioral change is presented. The aim of the study is to provide around the clock monitoring system to support people's suffering from Alzheimer or Parkinson disease at minimum intrusion level. The study uses classification techniques to detect abnormal behavior of personal energy usage patterns in the home. Other studies although do not utilize smart meters data, they use Internet of Things (IoT) infrastructures in smart cities for developing applications that monitor and provide health services for patients.

B. Extracting Frequent Patterns of Human Activities

As mentioned earlier, the aim is to discover human activity patterns from smart meters data. Our aim is to detect the patterns of these activities so that a health care application, that monitors sudden changes in patient's behavior (e.g. patients with cognitive impairment), can send timely alert to health care providers. Extracting human activity patterns is not only discovering the individual appliance operation, but also the appliance-to-appliance associations.

C. Clustering Analysis: Incremental k-Means

Discovering appliance-to-time associations is vital to health applications that monitor patients' activity patterns on a daily basis. In this section, a clustering analysis mechanism is used to discover appliance usage time with respect to hour of, time of day (Morning, Afternoon, Evening, Night), weekday, week and/or month of the year. 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. Using this data we can group a class or cluster of appliances that are in operation simultaneously or overlapping. The size of the cluster that describes such associations is defined as the count of members in the cluster as well as its relative strength. Clustering analysis is the process of creating classes (unsupervised classification) or groups/segments (automatic segmentation) or partitions where members must possess similarity with one another, but should be dissimilar from the members of the other clusters. The distinct advantage of the clustering analysis is the non-supervised nature of the process.

D. Bayesian Networks for Activity Prediction

In this section, we integrate the frequent patterns and appliance-to-time associations to learn about the use of multiple appliances and build the activity prediction model. The mechanism utilizes Bayesian network which is a directed acyclic graph, where nodes represent random variables and edges indicate probabilistic dependencies. An important benefit of the Bayesian network is the capability of mitigating missing data, learn relationships, and make use of historical facts and observations while avoiding over fitting of data.

VI. CONCLUSION

This proposed idea on mining human activity pattern for healthcare for people who stay back at home or old age peoples using Big Data algorithm provide accurate results whether a person suffers with any health problem by mining his/her frequent activity patterns generated by the smart appliances. Most of these activities can be learned from appliance-to-appliance and appliance-to-time associations. We presented incremental frequent mining and prediction model based on Bayesian network. In our current work,

through experiments, we found that 24-hour period was optimal for data mining, but we built the model to operate on any quantum of time. From the experiment results we have demonstrated the applicability of the proposed model to correctly detect multiple appliance usage and make short and long term prediction at high accuracy. The output of the system is utilized by specific health care applications depending on the intended use. For example, a health care provider might only be interested in knowing activities related to cognitive impairment where tracking the sequence of daily activities is crucial for reminding the patient when abnormal behavior is detected.

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