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Research paper

A survey on health prediction using human activity patterns through smart devices

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Abstract

The world is devoting massively towards digital transformation to provide a healthier environment for people who live in smart homes. In such a change millions of smart devices are being equipped around, which gives a massive amount of refined and sorted data which is used to analyze the health patterns. In this research, the work mainly focuses on analyzing the human activity patterns for health prediction through smart devices. This survey includes frequent pattern mining, cluster analysis, the measure and analysis of the energy utilization changes accordingly by household. This paper represents the survey depends on the needs of analyzing energy utilization patterns of the appliance level, which completely depends on the human activity patterns.

Keywords: *Smart Devices; Human Activity Patterns; Digital Transformation; Cluster Analysis; Bayesian Network*.

1. Introduction

The appeal for the healthcare resources is being widely overwhelmed by the digital transformation. According to study, by the year 2050 digital transformation acts a key role. By advancement of such machines, a huge portion of data will be generated from smart devices. For example, examining the changes in the appliance usage could be used for the indirect determination of the person's health depending on the previous data. As human practices are usually recognized by their daily actions, observing these actions help us identify the irregular actions that tell us about the humans troubles in taking supervision of themselves, like not cooking food, not taking bath, etc [3]. The interconnection between appliance usage and daily actions are used by the healthcare applications to identify future health issues. This decreases the burden on the healthcare systems and provides the observing service that automatically identifies regular and irregular practices of individual patients or those with self-constraining conditions [6]. In this way, the huge sets of data generated by smart devices are analyzed to support, healthcare services.

A method for collecting the information regarding the usage of energy, from the smart devices installed at homes, and get data that depends on the daily actions of the residents. This model detects and examines the meter-readings of smart devices to identify the activities. Intellectual study of that data can help to find the changes in behavior or in the health of the occupants [2]. Disaggregated power utilization readings are precisely associated with the actions performed at the house. For instance, if the ''Induction stove'' is switched ON, then it is most likely for ''Cooking Food''. The time at which it is working can also tell us about the kind of food like breakfast or lunch or dinner. However, people often work on multiple actions at the same time such as ''Using a vacuum cleaner'' and ''Hearing to songs'' or ''seeing programs over television'', which means diverse devices are functioned simultaneously [3]. Because of this, we study consumer's time-related energy utilization patterns at the level of the appliance to notice diverse appliance usages to predict there functioning. However, it is very demanding as it is not so simplistic to know about the usage interactions between different devices when their working occurs simultaneously [5].

Moreover, obtaining precise prediction results of human action patterns is dependent on the probabilistic associations between devices and their usage events that have different time intervals.

For handling the above-mentioned difficulties, the paper suggests prediction model and frequent mining to analyze power utilization differences are observed in the household behavior. The data from the smart meters are repeatedly observed in the quantum/data portion of 24 hours, and the results are preserved across subsequent mining activities.

The research work proposes is based on human action pattern mining model depends on the differences in appliance usage at homes. Frequent pattern tree for mining the entire set of a frequent pattern by pattern fragment growth for pattern recognition is observed based on the comparison between k-means clustering algorithm and hierarchical clustering algorithm to identify the appliance-to-appliance cooperative from the incremental mining of energy utilization data [11]. This is not only used to determine activity routines but also, used for detecting sudden changes of human activities when utilized by the healthcare application, which is required for the attention of a health provider [12].

2. Literature survey

[1] A paper on smart Meters Big data, Model for Fair Data Distribution in Deregulated Smart Grids, (2015).

This paper explains a technique for sharing, power utilization data in deregulated smart grids. The activities in daily living as a mean data categorization to assist the data aggregator and the consumers

to recognize privacy risk values. This paper used the concept of differential privacy as an anonymity mean to minimize the leakage of information.

[2] A paper on UK-DALE dataset, domestic appliance level electricity demand from smart homes of UK, (Sep.2015).

This paper adopted a dataset possessed from disparate homes. Smart homes contain a very large number of meter readings by the users of the smart homes equipped by smart devices. The content of the meter reading varies from home to home based on the usage level of the equipment by the residents. This paper introduces an approach to assemble data from smart homes based on the usage of the appliances installed.

[3] A paper on patient state recognition system for health care using speech and facial expression, (Dec.2016).

This paper explains a model to address an overall framework on health care. It mainly deals with the concept of identifying a patient state for providing good recognition accuracy to provide low-cost modeling. This paper mainly depends on two types of inputs considerably audio and video which is captured in a multi-sensory environment which showed average detection efficiency over 98 percent.

[4] Paper on smart Energy Irregularity Recognition Based on Behavioral Abnormality Detection (Oct 2016).

This paper proposes a data analytic access that classifies energy utilization abnormalities according to the behavioral deformity of the inhabitant. Research work mainly focus on identifying usage of appliances everyday by using devices like smart meter that track daily usage for the whole day, then knowing about the individual times of working and also each device's energy utilization. The main objective of this paper provides base level non-invasive health supervision technologies which can be given out on a large scale that can track with no other sensors working in any home with any number of people.

[5] A paper on detecting activities of daily living with smart meters, Advance Technology and societal Change (2014).

This paper explains the methods that are used to analyze smart meter data to monitor human behavior. A model Semi-Markov (SMM) is used to track and notice mode to analyze and find exclusive structures which define habits of the household. The second approach is based on a form that allows the disclosure of ADL's and focuses on a temporal search of ADL's. These methods rely on smart meter data regarding which home appliance was turned on.

[6] A paper on prediction of Appliance Usage with a Classification Approach Based on Time Series (May 2012).

This paper proposed a model which tries to validate a method using time-series based multi-label classifier which tells us about the relation between different devices between other parameters. The objective of this work is to implement a model which can forecast the appliance usage in the household that helps the system to stabilize power production and consumption to tell which device will be used at which hour.

[7] Paper on prediction system for home appliance usage (Sept 2013).

Power supervision in the home environment and workplaces include machine usage prediction as the forthcoming client wishes are not reasonable. The questions which are associated with the device usage make the expectation of the device use from power usage information a very hard work. An unbiased model for prediction at the level of device is as yet lacking. This paper proposes a model to upgrade algorithms with capable data and prescribes a widespread model utilizing a learning driven way to deal with recognized whether a particular device will begin amid an expected hour or not.

[8] Paper on big data analytics for demand response: Clustering over space and time (Apr. 2015)

This paper explains the motivational need for alternate representations of electricity consumption data, arguing that approach based on time-series representations are unable to mine implicit temporal patterns over a collection of huge consumption data from a diverse clientele base. This paper shows the usage behavior patterns identified at (i) different times-of-day, (ii) days-of-the-week, or (iii) at coarser granularities (i.e., by semester or yearly) for a clientele and similarities are mined between clientele's with phenomenally different characteristics by exactly clustering time-series data.

[9] Paper on data mining practices for sensing household features based on smart meter data (Aug 2015)

The goal of the paper is to manage the structure of household device's utility patterns, hence giving more information in smart metering systems in view of the utilization and the cause of their utilization. Many unsupervised machine learning methods are used to discover usage patterns observed in different households. The task carries the solutions suitable for smart metering systems that might help to sophisticated power consciousness; backing precise use predicting and gives the information for demand systems in households with periodical energy-saving suggestions for clients. This paper delivered some results which show that defining house features from obtained data is accurate and provide for extracting trends in data.

[10] Paper on a frequent pattern tree approach for mining frequent patterns without candidate generation (2004 Apr)

The significance of frequent pattern mining in the field of data mining is to discover affiliations, intermittent examples and so forth among various datasets that are in a database. The past examinations have used Apriori calculations. As, Apriori is costly, especially when there are various examples, this paper proposed a frequent-pattern tree structure, which is an broadened prefix-tree structure for filling firmly related, generous information about successive patterns, and build up a competent FP-tree based mining plan. The results outline that the FP development technique is competent and open for mining commonly long and short regular examples, and is snappier than Apriori calculation.

[11] Paper on Data mining: Concepts and techniques on Cluster Analysis, Concepts and Methods, (2011)

A cluster is a mixture of related data objects inside a cluster and dissimilar data objects are outside the clusters. The procedure of merging objects into modules of similar data objects is called "Clustering". Ability to deal with the different data sets and their attributes, identifying the constraints within input data, detection of cluster subjective shape and interpret-capability. The well-known clustering techniques are grid-based, partitioning based, density based and hierarchical methods.

[12] Paper on Bayesian Network for Data Mining

This paper explains Bayesian network used to learn relationships, also helps to gain better knowledge about the problem and to predict the significances. This gives better representation for uniting earlier knowledge and data. This paper proposes the construction of Bayesian Field networks using a different kind of methods with the acquired knowledge and existing data.

[13] Paper on smart meters big data on incremental mining of frequent power consumption patterns (Oct 2016)

This paper explains, the energy usage performance replicates appliance associations and their usage. The utilization of information from a smart device is a constant process. After a certain portion of time, the inter-associations among the appliances may alter with time and new patterns may establish. This also illustrates the power consumption of a home that can be estimated by the data consisting of devices utilization tuples for 24hours in a increment manner.

[14] Paper on Top 10 algorithms in data mining (2008)

This is a survey paper which explains the best algorithms which in the list of top 10. It contains the different algorithms of data mining. Among which some are clustering, incremental pattern mining, prediction etc. It the detailed explanation of the each and every algorithm proposed in the paper. All these algorithms are classification algorithms. In this all the algorithms are tested and the results are compared to each other based on which the numbering of the algorithm.

[15] Paper on comparative study of k-means and Hierarchical Clustering Techniques (2014)

The revolution on Data mining has been examined as a very helpful method for recognizing sequences and knowledge discovery of

a substantial volume of information. There are numerous ways to obtain the unfamiliar sequences out of the huge dataset for real-time and business applications. The K-means algorithm can accomplish clustering on large data sets and its proficiency surges as the number of clusters increases. Hierarchical clustering was adopted to resolve the problems with unconditional data, but because of its quadratic time complexity O (n^2), a new approach with linear complexity i.e. O (n), k-means is used with categorical data for assigning rank values. Considering their time complexities k-means algorithms give better results compared to Hierarchical Clustering Algorithm.

[16] Paper on data mining technologies for detecting household characteristics based on smart meter data (2015).

The patterns generated give us the clear information regarding the appliance usage and the association of the different appliances at a time. In this regard, each and every house data patterns are compared with that house previous pattern. In this paper, the researchers reveal particular usage patterns of unsupervised machine learning techniques. This helps in identifying the energy saving techniques as well as used for healthcare prediction using appliances.

[17] Paper on International comparison of household energy consumption and its indicator (2008).

The lifestyle in consumption of energy is discussed in this paper differing from countries. The energy utilization of each and every country is compared based on the time stamp. To overcome the growth in Utilization of energy the researchers recommend the best practices in the paper.

[18] Paper on localization Technologies for Indoor Human Tracking (2010).

This paper describes the usage of the wireless localization technologies for individual people in the urban areas. These localization techniques include the GPS (Global Positioning System) for identifying the individual's behavior and actions, inside the building. These services can be represented as the state-of-art technologies.

[19] Paper on cloud-Supported Cyber-Physical localization framework for patients monitoring (2015).

The proposed model in this paper is the CCPSs which mean the "cyber-physical systems" this facilitate the integration of the devices of the physical world with cyberspace. The devices are such as speakers, cameras, GPS systems etc. As in the above paper, this paper also uses the localization technologies in monitoring the patient behavior. The approach for localization in this model is GMM (Gaussian mixture model).

[20] Paper on using consumer behavior data to reduce energy consumption in smart homes (2015).

The main aim of the paper is to know the energy savings autonomously in the smart homes. The data sets are collected based on the different patterns formed. The algorithms used in this paper are the frequent sequential pattern mining and the recommender system which gives the notification to the user to decrease energy utilization.

3. Overall survey

This survey helps to propose a model that analyzes human action patterns of smart home residents for prediction of health. To implement this model, we need to collect the smart home data and apply Frequent Pattern Mining algorithm like FP-growth, Apriori Algorithm and Clustering techniques like K-means, Fuzzy C-means and also hierarchical clustering. The obtained result set is used to generate a trained Bayesian network, for classifying human activity patterns to predict abnormalities in the behavior of smart home residents.

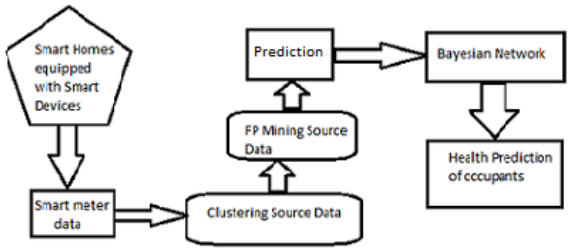

Fig. 1: Model for Health Prediction.

4. Future enhancement

Future research work includes the support for smart city services; thus suggest a prototype that uses big data that is generated from the smart home as a way of understanding and discovering human activity patterns to develop healthcare applications. Prediction techniques are used for analyzing the usage of energy utilized by occupants using techniques like Bayesian network and rule-based trending. Giving alerts to the occupants or care-takers in order to detect their abnormal activities.

5. Conclusion

The world is being digitalized with the huge number of homes are being furnished with smart devices the continuous generation of large volumes of fine-grained data has been analyzed and the demand for the health care resources is being widely affected by the digital transformation. In this work, we presented the overview of pattern mining for health prediction. Through this work we conclude that FP-growth and K-Means are giving the best results for frequent pattern mining and clustering respectively.

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