

Chapter 7

Improve Home Energy Management System by Extracting Usage Patterns From Power Usage Big Data of Homes' Appliances

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ABSTRACT

Many researchers have focused on the reduction of electricity usage in residences because it is a significant contributor of CO₂ and greenhouse gases emissions. However, electricity conservation is a tedious task for residential users due to the lack of detailed electricity usage. Home energy management systems (HEMS) are schedulers that schedule and shift demands to improve the energy consumption on behalf of a consumer based on demand response. In this chapter, valuable sequence patterns from real appliances' usage datasets are extracted in peak time and off-peak time of weekdays and weekends to get valuable insight that is applicable in the HEMS. Generated data in smart cities and smart homes are placed in the category of big data. Therefore, to extract valuable information from such data an architecture for the home and city data processing system is proposed, which considers the multi-source smart cities and homes' data and big data processing platforms.

INTRODUCTION

Incorrect utilization of appliances alongside absence of a smart energy infrastructure leads to unnecessary energy consumption and waste in most places. Many researchers have focused on the reduction of electricity usage in residences because of its role in CO₂ and greenhouse gases emissions. However, electricity conservation is a tedious task for residential users due to lack of detailed electricity usage data.

DOI: 10.4018/978-1-5225-5384-7.ch007

Today, thanks to development of sensors, the power use information of apparatuses can be gathered effortlessly. Specifically, an expanding number of smart power meters, which helps data collection of appliance usage, have been deployed. If representative patterns of appliance electricity usage existed, inhabitants can adjust their apparatus utilization to conserve energy effectively (Chen, Deng, Wan, Zhang, Vasilakos, & Rong, 2015). Appliance usage patterns offer clients better assistance with understanding how they utilize the apparatuses at home and distinguish irregular uses. Additionally, appliance manufacturers may be encouraged to design clever control of smart appliances (Chen, Yi-Cheng, Chen, Peng, & Lee, 2014).

Data analysis system of smart environments is an instance of the context-aware applications, which help to make decisions in such a way to benefit the users of the system by analyzing and reasoning about the environmental situation. Home energy management systems (HEMS) are a kind of such systems in the smart home. HEMS schedule and shift demands to improve the energy consumption on behalf of a consumer based on demand response. Considering multiple objectives such as energy costs, environmental concerns, load profiles, and consumer comfort, HEMS usually create optimal consumption and production schedules.

In this research, valuable sequence patterns from real appliances' usage dataset of SGSC (Motlagh, Foliente, & Grozev, 2015) are extracted using PrefixSpan (Han et al., 2001) in peak time and off-peak time of weekdays and weekends to get valuable insights that is applicable in HEMS. Data generated in smart city and at smart home is placed in the category of big data as it has similar challenges as described in (Russom, 2011) (Honarvar, & Sami, 2016), and that can best be attributed along the so-called 3 V's: Volume, Velocity, and Variety. Therefore, to extract valuable information from such kind of data architecture for the home and city data processing system is proposed which considers the multi-source smart cities and homes' data and big data processing platforms.

The experiments in this research were implemented on the proposed system in which Spark is used as the main big data processing engine. The contributions of this research are as follows: 1) Extracting usage sequences from the power usage data of each appliance in four cases (off-peak time of weekdays and weekends, peak time of weekdays and weekends) which can be used as valuable information for HEMS to schedule the devices using multiple objectives such as energy costs, environmental concerns, load profiles, and consumer comfort; 2) Proposing a big data architecture for the home and city data processing system which considers the multi-source smart cities and homes' big data; 3) Some findings show that the dataset and the imbalanced distribution for computations can impact the efficiency of PrefixSpan when implemented on a distributed environment such as Apache Spark.

Background is surveyed in the following. Then on the proposed system architecture and datasets are introduced. After experiments and results are given, future research directions and conclusions are listed.

BACKGROUND

Big Data

Big Data is the unavoidable result of our ability to create, collect and store digital data at a never-before-seen scale. This generation and collection of large datasets has further encouraged analysis and knowledge extraction process with the belief that with more data available, the information that could be obtained from it will be more exact. In any case, the standard calculations that are utilized as part of data mining

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