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A Study on Efficient Building Energy Management System Based on Big Data

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Abstract

We aim to use public data different from the remote BEMS energy diagnostics technology and already established and then switch the conventional operation environment to a big-data-based integrated management environment to operate and build a building energy management environment of maximized efficiency. In Step 1, various network management environments of the system integrated with a big data platform and the BEMS management system are used to collect logs created in various types of data by means of the big data platform. In Step 2, the collected data are stored in the HDFS (Hadoop Distributed File System) to manage the data in real time about internal and external changes on the basis of integration analysis, for example, relations and interrelation for automatic efficient management.

Keywords: *Building Energy Management System, Big Data, MapReduce, Hadoop, Data Aggregation*

1. Introduction

Recent global warming contributes to abnormal weathers, and heat waves not forecasted even by the Korea Meteorological Administration. Such abnormal hot weathers cause nation-wide large-scale power outages and poor power supply to create an issue of energy consumption. Furthermore, energy consumption by buildings is about 25% of total energy consumption to suggest an issue of building energy reduction, and a need for efficient energy use in buildings. For efficient energy use and management, an emerging analysis and diagnostics technology is based on the BEMS (Building Energy Management System). With BEMS data for analysis, cooling and heating energy use and consumption patterns are known and energy can be efficiently distributed [1]. The BEMS technology is being made as a system which reduces building energy use and energy costs by enabling control in addition to energy use measurement visualization, analyzing and systematizing huge information in cooperation with monitoring, control, energy analysis, simulation and information management systems linked to IoT to make rules practicable for and available to end users.

Using the BEMS in different diagnostics perspectives reveals 1.9% to 15% for energy reduction, and 4.9 to 13.9 years for a cost recovery period. Introduction of the BEMS is better than improving building hardware in terms of costs [2].

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This study suggests an analysis method for collecting and automatizing data from public information, which is different from the remote BEMS energy diagnostics technology generally used.

2. Related Studies

2.1 BEMS (Building Energy Management System) Technology

BEMS technology is developing fast to be linked to IoT now in addition to measuring and visualizing the use of energy and is changing from the closed type to an open-type system.

An ordinary BEMS system is composed of a monitoring system, a control system, an energy analysis system, a simulation system, an external and connection system, and a basic information management system.

Figure 1. BEMS Technology Overview Diagram

It is changing from the closed type to the open type in connection with the integration system for each enterprise as the automatic building control network is standardized in the enterprise-dependent technology depending on systems. Although it is switched to and operated as an open system, it is still required to develop services for analyzing and automatically processing data in platforms [3].

2.2 Increasing Energy Efficiency and Analyzing Improved Reliability

The most essential thing for efficient use of building energy is economic and reliable measurement. First of all, it is already said above that measurement requires much time and costs, and many methods are used for more reliable measurement.

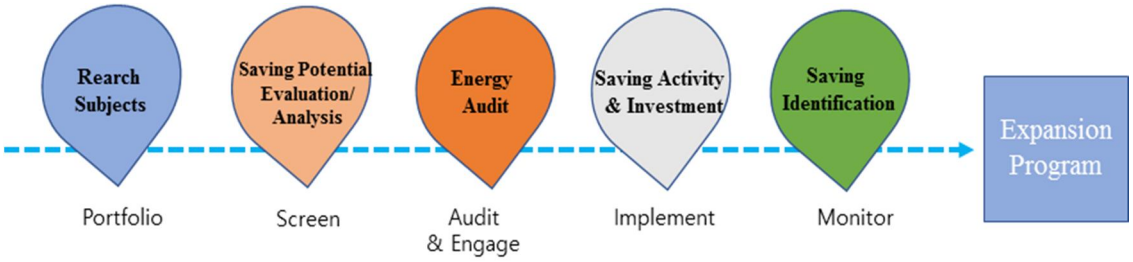

Figure 2. Increasing Energy Efficiency and Analyzing Improved Reliability

Using a system composed of an air-conditioner and a convector in an office building enables appropriate preheating time and energy use to be reliable [4]. It is possible to compare and verify a model for predicting room temperature by using the data-based modeling technique [5].

Using public data to control systems allows a system to be built fast, and the same algorithm to be applied to ensure standardized data. As a result, efficient energy performance improvement can be implemented for other buildings.

2.3 Big Data Hadoop Framework

For processing the big data related to energy, NoSQL less limited than the conventional relational database is used in order to store and use the data saved by using the Hadoop framework, achieve consistent and suitable processing for distributed processing, and application of databases highly extensible.

The Hadoop framework provides the large-scale data processing programming model, MapReduce, and the distributed file system, HDFS (Hadoop File System) [6]. The MapReduce programming model and the large-scale distributed data processing framework ensure and provide GFS technology to enable large-scale data to be stored and extended effectively.

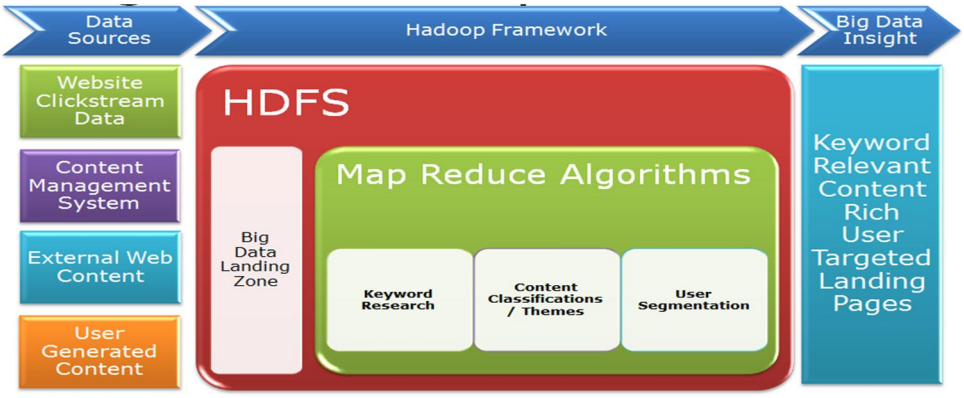

Figure 3. Big Data Hadoop Framework

3. Proposal of Service Integrated with BEMS, Based on Big Data

Because the energy management system based on big data does not use any presumption in the process of dividing use of energy for each purpose, unlike other remote BEMS energy diagnostics technology, and is based on data, the system applicable to urban building is proposed.

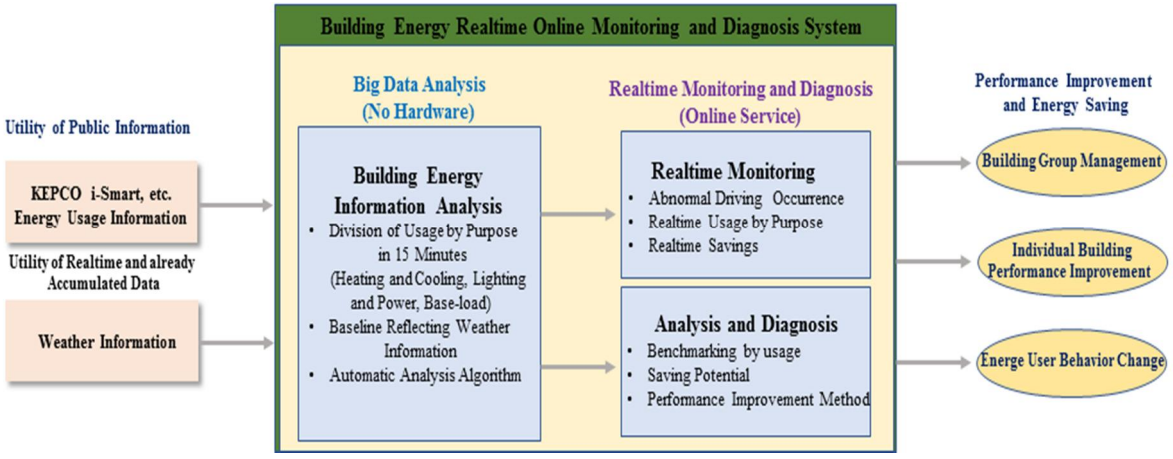

Figure 4. The Building Energy Management System Based on Big Data

The new MapReduce method is proposed to combine and reclassify user's data logs with the MapReduce engine for mapping and reducing data through distributed big data processing by means of the conventional Hadoop framework.

The MapReduce engine is used to map source data of big data by IPs, reduce the scope as much as possible and then compare/analyze the energy use network logs of a concerned building. Kibana is used to provide the data to users in visual format in real time by using an open source. The data is distributed and stored through the framework and HDFS for processing data sets in parallel and undergoes distributed processing through MapReduce to combine a plurality of computers as if they are one computer to increase storage space and computation capacity. The method is proposed for the MapReduce mapping engine conducting mapping and extraction with the function Map by IPs of allocated energy consumers and processing meaningful minimized data by means of the function Reduce.

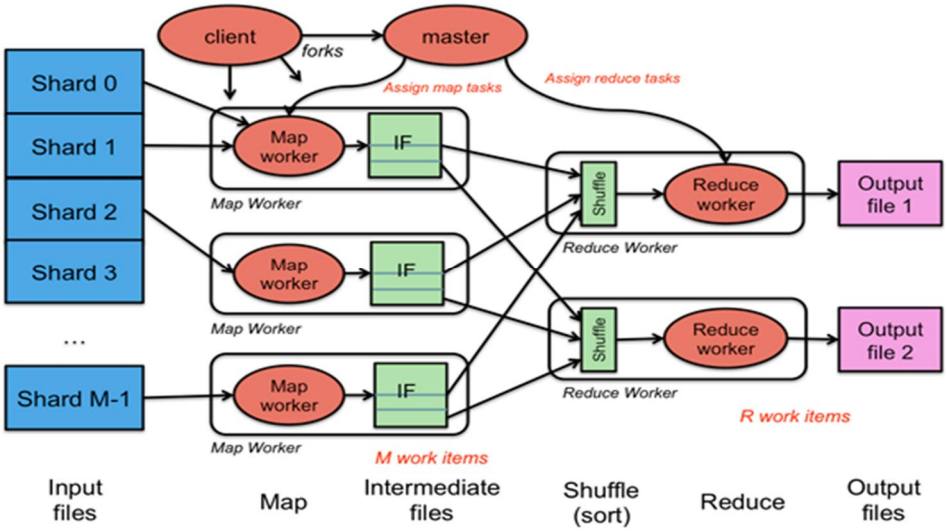

Figure 5. The New MapReduce Method by means of Hadoop Framework.

Because different network data are collected depending on seasons, years, regions and situations, fast response to possible external threats is allowed through network analysis by regions. The proposed customized BEMS method to which the system is applied is for providing real-time monitoring to collect and analyze data because the data for network data collection of each region are different to analyze collected energy discharge in the network and external climate changes, analyze disclosed global big data to analyze concerned customer′s related logs, integrate/analyze the logs with the logs integrated in the network and thus estimate future energy consumption.

4. Conclusion

Building a big data platform to create an environment allowing integrated management for the conventional operation environment enables even easier building energy management and operation. The new method proposed is for integrating the big data platform with the conventional EMS management system to use various types of logs of the network management environment, collecting logs of silo type data in the network and end points through the big data platform to store them in HDFS (Hadoop Distributed File System) for integrated analysis including associated relation analysis and interrelation analysis, in order to manage data based on external changes in real time. This new method allows abnormal situations, for example, critical internal information leaks, to be detected, and is applicable through the Hadoop-based big data platform.

While the Hadoop big data platform gets popular for network management, integrated network

management is implemented, and Hadoop-based big data analysis allows all types of logs (structured/semi-structured/unstructured) to be integrated, collected and stored to vitalize the use of BEMS solutions based on big data technology for analyzing logs larger than tens to hundreds of TB (terabyte) data fast. Applied to all buildings in a given area, the building energy management system based on big data analysis searches for buildings of high energy saving potentials for intensive performance improvement, compares and analyzes buildings of high energy performance among the buildings of average energy performance to find issues involved in operation for continued improvement. The system provides energy users with currently reduced energy consumption in real time of a concerned building, and rankings of performance and saving in the concerned building for users′ attention and participation in energy saving to improve energy saving significantly. It is required to further study how to design the proposed method for the building energy management system based on big data and implement the system.

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