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Cloud Computing based Livestock Monitoring and Disease Forecasting System

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Abstract

Cloud computing, an internet-based computing technology, is a web-based software service of calling and using programs placed in the internet utility data server via computer or mobile phone according to user's need. In this thesis, web-based cloud computing technology will be applied to livestock farms to develop livestock monitoring and disease forecasting system at existing livestock or apply to system that has already been developed. The proposed system uses column-oriented database Hadoop HBase to store and manage livestock environment & livestock database and implements livestock environment monitoring and facilities control through the parallel processing via MapReduce model. Since the proposed system is web-based, there is no server development cost when internet is connected, and livestock data is managed at the main server to efficiently and convenient manage livestock.

Keywords: *Livestock, Cloud Computing, monitoring, disease forecasting*

1. Introduction

These days, cloud computing comes to the forefront as a means to store and manage big data. Cloud computing refers to a way of computing service in which users can borrow and use computer resources such as hardware and software existing without fixed form as the cloud as much as they want and pay fees. By adopting cloud computing, businesses and individuals alike can reduce huge amount of expenses, time and labor force including expenses to maintain and manage computer system, purchase and installation expenses, update expense, software purchase expense, and can also have the advantage of energy saving. These advantages allow cloud computing to be used in diverse fields such as healthcare, finance and education, and is extending its area to computational science field particularly since the announcement of Google's MapReduce model of parallel processing [1].

Korea's output of livestock industry in 2013 - 18 trillion won - accounts for 41.2% of that of agriculture and livestock industry, showing remarkable development compared to 25.4% share in 2000. However, the need for systematic monitoring system and disease forecasting technology is increasing from the changes of full commercialization and scalization as a result of livestock worker reduction and livestock farm restructuring, as well as damages from various livestock diseases [2].

This study proposes cloud computing-based monitoring and disease forecasting system for the livestock industry experiencing such difficulty. Since the existing systems manage sensor data using distributed database system either in a single server or multiple servers

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built in grid, they have the demerit of not easy system extension and high expenses of system construction and management. Cloud computing technology proposed in this study aims to reduce installation charge, personnel expenses and energy needed for operation by means of server lease[3, 4].

This study is about management system which conducts distributed storage and parallel processing of large-scale sensor data collected from a number of livestock. The proposed system stores sensor data transmitted by cloud at Hadoop HBase, distribution column-oriented database. Distribution column-oriented database, which distributes and stores duplicately at many nodes, has excellent extension and is easy to do parallel processing of MapReduce. This study suggests data schema for efficient search and designs, implements sensor data processing module based on MapReduce. The system allows users to be connected with diverse platforms, as it is designed so as for them to transmit and get the result through application [5, 6].

Chapter 2 examines the system that uses cloud through related studies, and Chapter 3 describes the composition diagram of cloud-based livestock monitoring & disease forecasting system, data schema design, application, and PC program, and this thesis will be concluded in Chapter 4 through conclusion.

2. Related Research

This chapter examines the system using cloud technology.

2.1. Cloud-based Real-time Collaboration Service

Figure 1. Cloud-based Real-time Collaboration Service

To provide cloud-based real-time collaboration service, means of communications through mobile were integrated. This service connects with staff in charge in real-time during the process of task processing without delay to allow real-time decision-making, and allows task processing for an extended period of time via smart phone without offline meeting, thereby improving the accessibility between colleagues. It allows seamless task support that prevents the delay of subsequent task and shortens the lead time of decision-making to remove the uncertainty of task through swift approval [8].

2.2. Cloud-based Mobile Office Service

A new service has appeared to provide cloud-based mobile office. As for the content of this service, it provides the service of simultaneously processing task by connecting through the virtualization technology provided by cloud-based mobile office service for the business task of legacy system and mobile app located in cloud for external mobile users or internet wi-fi user to provide cloud-based mobile office, as shown in Figure 2[8].

Figure 2. Cloud-based Mobile Office Service

2.3. Cloud-based Small & Medium Automobile Parts Combined Information Service

Could-based real-time manufacturing process management service and cloud-based integrated information system service for small & medium automobile parts companies. To improve the process of plant, status inside manufacturing plant is monitored remotely to provide service for implementing real-time enterprise (RTE). This allows real-time manufacturing process management through the remote monitoring management of plant utilities, facilities, workers and delivery vehicles through integrated control center. In addition, it is a service that allow the management of workers, facilities and inventory location tracking and route management of delivery vehicles by using related system and related organization through analysis on accumulated data through monitoring. In addition, as shown in Figure 3, cloud-based integrated information system service for small & medium automobile parts companies is a service that is currently being implemented at Chungnam TP Automobile Parts R&D Center and SAP solution has been implemented to improve the information of small & medium automobile parts companies to provide highest level of service. In addition, it has applied cloud computing-based service by applying virtualization technology for future expansion, and companies that receive the service can apply one of the ERP, MES and 3D Simulation solutions[8].

Figure 3. Cloud-based Small & Medium Automobile Parts Combined Information Service in Chungnam TP

2.4. Cloud Robot

Figure 4. Cloud Robot

The concept of cloud is also being applied in the area of robot, and cloud robot is a service technology of providing results upon quickly processing or performing via cloud for various data, information and application software (app or contents) used in robot. Through distributed processing technology using multiple servers for information and knowledge system on application environment that robot does not have, it can quickly search and process and allows sharing through knowledge database. In addition, it is a service to obtain results by quickly processing through distributed processing technology using multiple servers for robot task that requires high volume computing power. In recent, technology is being developed for seamless performance of service with the goal of responding to changing environment by integrating with IT device, sensor and humans centering on robot through cloud service[8].

3. System Design

Livestock monitoring and disease forecasting system in this study proposes cloud computing-based livestock monitoring and disease forecasting system by integrating a number of livestock. Figure 1 shows the overall conceptual diagram of the proposed system.

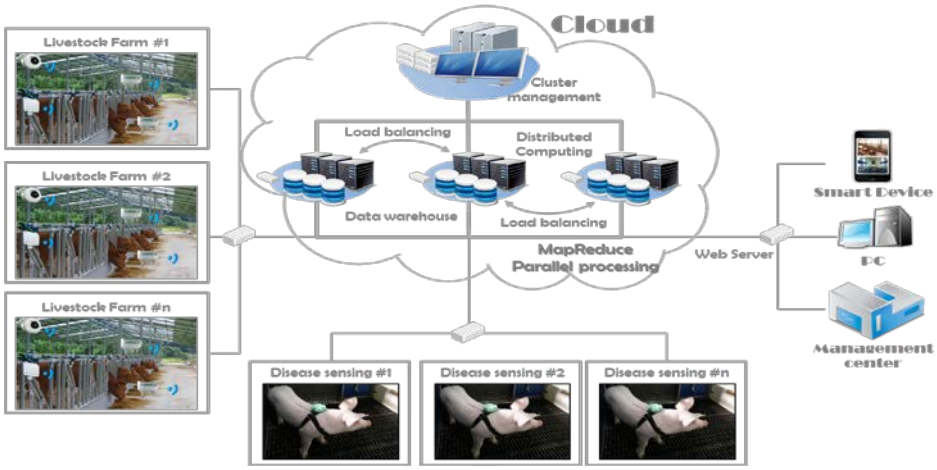

Figure 5. System Conceptual Diagram

3.1. System Structure

Cloud computing-based livestock monitoring and disease forecasting system in this study is based on Hadoop cloud of the Apache Group as following Figure 2. Hadoop used

in this study is open-source framework of Google's distributed file system and MapReduce; free Java software framework, which operates from clusters and supports distributed application programs.

Above all, the system builds HDFS based on Hadoop core, forming many nodes into a single cloud, and installs HBase there so that the system can store sensor data collected from livestock as well as facility state information. Data stored like this provides service of livestock monitoring, livestock facility control, disease forecasting by means of integrated management system based on MapReduce parallel processing modules.

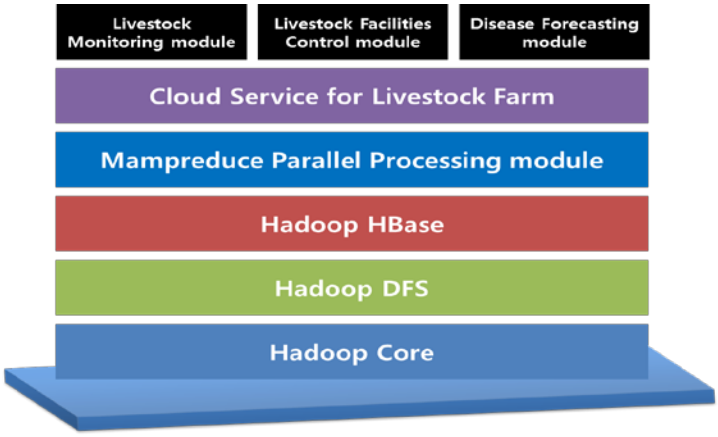

Figure 6. System Structure of the Proposed System

3.2. Design of the Environment & Facility & Disease Forecasting Data Schema

As for the measurement items for livestock environment management, they consist of environment factors that affect livestock breeding such as illumination, temperature, humidity and gas, and facilities that can control livestock environment such as lighting, humidifier and air conditioning ventilator, and acceleration sensor for disease forecasting. Building on Google's BigTable model, which is different from the existing RDBMS, livestock management data in this study uses HBase - distribution column-oriented database embodied on HDFS. Design of another schema is needed for efficient storage and quick search.

Table of sensor_id is the one storing sensor information and each sensor belongs to ev_livestock_id group according to installed livestock. For easy sensor search, low key is formed by combination of <livestock_id> and <sensor_id>. To store information at sensor, sub-columns are made up of <sensor_info> storing metadata of sensor and <location> storing location information of sensor.

As a sub-column, table of sensor_type has <type_info> showing types of sensor and data as well as unit and <valid_range> showing range of normal data. Table of sensor_data is the one storing collected sensor data, and low key is formed by combination of values of <sensor_id> and reverse-timestamp for user's easy search of recently-collected data and efficient range query. Lastly, table of facility_livestock divides types and units of the facility through <facility_info> and stores real-time state of the facility.

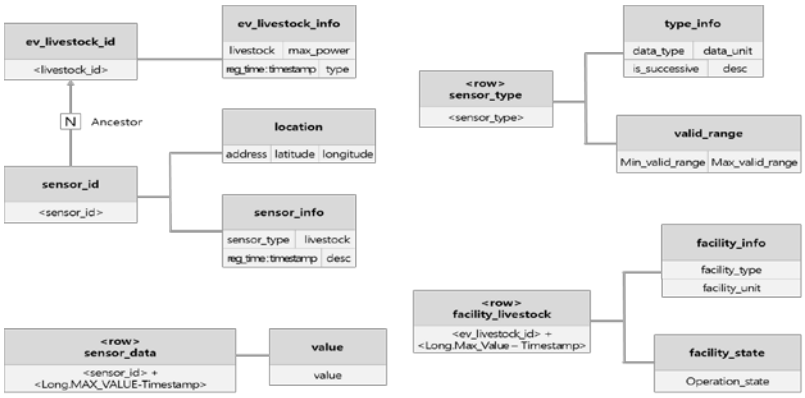

Figure 7. The Data Schema of Livestock Environment Sensor and Facility

3.3. MapReduce based Livestock Environment Data Analysis Service

Following parallel processing based on MapReduce model, data stored distributed in HBase within cloud provides service of livestock monitoring, environment monitoring and facility control. Stored data conducts user query in parallel at each node through Table-Mapper and the result of key-values acquired as such is transmitted to TableReducer by being aligned and duplicated. TableReducer incorporates these results and stores final results in its table.

3.4. Livestock Disease Forecasting Service

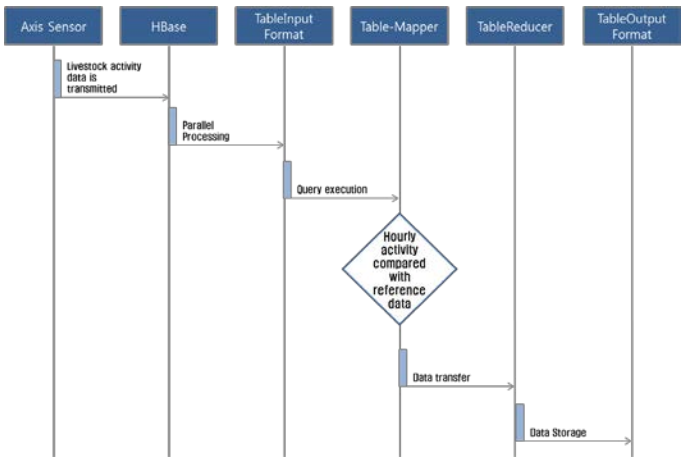

Figure 8. Livestock Disease Forecasting Service Process

Disease forecasting service is provided using three-axle acceleration sensor. When livestock is infected with disease, the amount of its activity decreases or increases than normal and it detects this. Module with acceleration sensor is attached to the body of livestock to detect movement and the signal is stored in dispersion in HBase. Afterwards, inquiry is performed at Table Mapper to determine disease status and stores data through TableReduce(7).

3.5. Cloud Robot

As for the system proposed in this thesis, it provides application for the latest update iOS 7.0.x by using Xcode 4.6.x IDE that runs based on MAC OS 10.8.x. Figure 4.a is a screen for searching sensor data under various conditions. When user selects desired condition, server that has received inquiry transmission performs MapReduce for parallel processing of sensor data display the result on the screen. Figure 4.b is the result of

performing the condition entered by user and it is displayed in table format. Figure 4.c is a screen of livestock disease forecasting service and when user selects acceleration sensor ID, activity amount information on livestock attached with the sensor of the ID is displayed in graph format.

Figure 9. Application Interface

4. Conclusions

This thesis proposed various services using the environment data that is generated at livestock, as well as facilities data and livestock activity amount data. To collected these data, sensor network is mainly utilized. Since data is continuously generated in system using sensor network, it is necessary to establish server that is ease to expand and that can efficiently manage the data. Accordingly, HBase was used for the cloud computing system proposed in this thesis for optimum performance under such condition, and MapReduce parallel processing model was used for effective search and management. Various effects are expected through the system such as cost reduction, productivity enhancement and user convenience.

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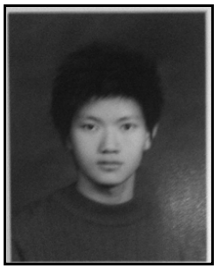

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