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Research on School Intelligent Classroom Management System Based on Internet of Things

Zhi Min Zhu*[11], Fang Qin Xu[2] and Xia Gao[2]

[1] *Donghua University, Shanghai 201620, China*
[2] *Shanghai Jianqiao University, Shanghai 201306, China*

Abstract.

With the increase in the number and size of school campuses, the issue of campus energy waste has received extensive attention. In order to monitor the environment of the classroom, control the electrical appliances to reduce energy consumption, and analyze the environment and utilization of the classroom, this paper develops an intelligent classroom management system based on the Internet of Things. In this system, the sensor suite of Shanghai Qixiang Technology Co., Ltd. is used as the basic suite of the Internet of Things. The storage model is established by the relational database MySQL and the non-relational database HBase. And the B/S-based website is the user interface. The storage overhead is reduced to a certain extent, and the energy waste in the classroom is effectively reduced.

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Keywords: Smart Classroom, Internet of Things, Distributed Storage.

1.Introduction

Due to the lack of attention of the leadership and the lack of effective management, the school's power was wasted. It is not uncommon to leave the classroom without turning off lights, fans, and air conditioners. At the same time, the computers and switches in the equipment room consume a lot of power when they are not in use. However, in the process of automatic control, it is necessary to evaluate a large number of parameters, such as automatically turning off the lights in the room, and need to judge the current external light intensity, whether the classroom is active or not. At the same time, the indoor environment has a direct impact on people's health, quality of life and

[1] Corresponding Author. Tel.+(86) 17317679257
*Emial: 2181811@mail.dhu.edu.cn

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work efficiency [1]. With the development of the Internet of Things, people can get the surrounding environment at a lower cost. In order to achieve energy saving and emission reduction in schools, it is necessary to intelligently control the school's lamps, air conditioners, projections and other electrical equipment. However, in order not to affect the learning and working environment of teachers and students, it is necessary to find a balance that can save energy, reducing the operating costs of schools and meet the daily needs of teachers and students. Therefore, environmental data of classrooms and offices are needed to record the activities of students and teachers, the environmental changes in the room and the use of electrical appliances, and to analyze the data in the later stage to find a balance point.

However, the amount of data generated spontaneously by the Internet of Things is very large. Each classroom generates a large amount of environmental data every day. The traditional relational database can no longer meet this demand. There is an urgent need for a new way to store data. Big data technology The emergence of this can solve this problem very well.

The development of various colleges and universities has reached the corresponding scale, and wireless and wired access to teachers and students provides a stable, reliable and bordered online experience. On this basis, it is feasible to set up gateways in classrooms and offices for uploading environmental data and accepting commands to control indoor devices. The solution for campus Internet of Things is also increasing. Even in classrooms without a network cable, campus network can also be connected by a wireless network. With the increase of the device, the IP address of the gateway device and the identification of the source sensor may cause storage errors. At the same time, the amount of data spontaneously generated by the Internet of Things is very large, and each classroom generates a large amount of environmental data every day. Traditional relational databases have been unable to meet this need, and a reliable read and storage scheme is needed to manage the data.

Based on the Internet of Things technology and combining relational database, non-relational database and distributed file system, this paper develops a smart environment management system for colleges and universities. It overcomes the isolation and regionality of the traditional way, and has the advantages of global optimization, unified management, simple and reliable, and high economic benefits. In the file structure of HDFS the NameNode manages multiple DataNodes, and the data is stored on the DataNode. The SecondNameNode can keep system running when the active management node fails, achieving high availability of the distributed file system.

2. Technical Route

The Internet of Things is a network extended from the Internet. It uses mobile communication technology to realize information transmission and cloud computing technology to realize data analysis and processing, and finally achieve information communication and decision-making. With the development of the Internet of Things, the concepts of smart cities and smart homes appeared and smart campuses have also begun to be mentioned.

Mysql is the most popular relational database management system. It is one of the best RDBMS applications in WEB applications. Hbase is a type of NoSQL, a distributed storage system for column-oriented storage. It can be used to replace the traditional relational database for the storage and management of massive data, and to ensure the high efficiency of massive data storage. It also meets the scalability, flexibility, reliability, and availability required for IoT data storage.[2]

The relational database is easy to understand, use, maintain, and supports SQL statements. It can be used for complex queries, but the read/write performance is poor, the table structure is fixed, and the reading and writing efficiency of massive data is low. Non-relational databases have higher read and write performance, no data coupling, and multiple storage formats, but no transaction processing and no SQL support. Combining the advantages of relational database and non-relational database, a storage method combining the two is proposed, which can satisfy the simplicity of ordinary query and meet the storage requirements of massive data.

HDFS is a distributed file system that uses blocks as a separate storage unit to store files larger than any disk capacity in the network. At the same time, blocks are ideal for backups to improve data fault tolerance and increase availability.

3. System Design

Figure. 1 shows the architecture diagram of the school intelligent classroom management system. As the IoT awareness layer, the sensor collects environmental data. In the network layer, the sensor data is aggregated to the gateway through the Zigbee network. The gateway integrates the data and then passes the data. The campus network uploads the data to the server.

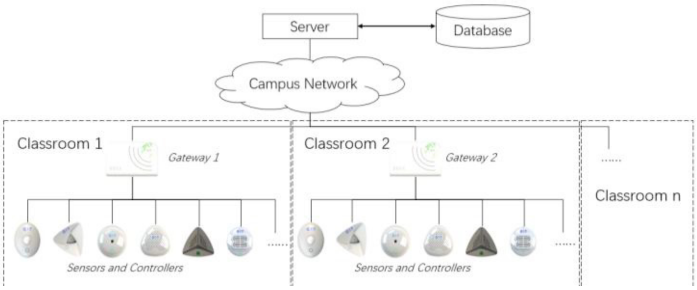

Figure. 1. Architecture Diagram

The server will save the data, as shown in Figure. 2(a), the data storage and query plan of the school intelligent classroom management system. MySQL relational database is used to store relational data, such as room information, sensor information, etc.; HBase non-relational database is used to store environmental data. When data is read, the system first enters the information of the requested data in MySQL, and then reads the specified unstructured data through the specified ID to Hbase, and then converts the data into readable information and displays it.

4. Hardware Design

4.1 Sensor Selection

The sensing layer sensor uses various environmental monitoring sensors such as temperature sensor, humidity sensor, smoke sensor, carbon dioxide sensor, gas sensor, human body infrared sensor, air pressure sensor, PM2.5 sensor, illumination sensor, etc. produced by Shanghai Enterprise Information Technology Co., Ltd. The sensor is shown in **Figure. 2**(b). From top left to right are illumination sensor, temperature and humidity sensor, PM2.5 sensor, gas sensor, carbon dioxide sensor and smoke sensor.

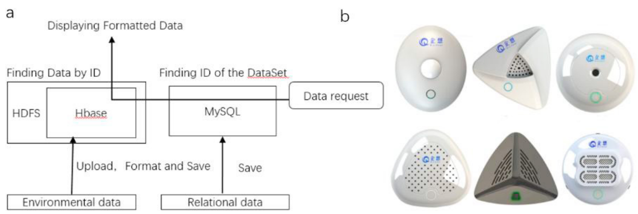

Figure. 2. (a)the Data Storage and Query Plan; (b)Sensors

It is also equipped with relays, RFID door magnets, alarms and infrared transponders. The relay can control facilities such as lamps and curtains. The function of the RFID access control is to identify the identity of the user, and the user needs to use the student card or the teacher card for identity verification when entering the room. The alarm can sound an alarm when the room enters a dangerous state, such as excessive temperature, excessive concentration of dangerous gas or excessive smoke dimming rate. The infrared transponder can control the electrical equipment of the classroom, such as projectors and air conditioners.

4.2 Data Format

The data format uploaded by the gateway is shown in **Figure. 3**, a total of 33 bits. The temperature value takes up positions 1-4. Bits 5-7 are humidity values. The 8th and 9th positions are the smoke concentration values. The 10-13th position is the carbon dioxide concentration value. Bits 14-17 are gas concentrations. The human body sensor is shown at the 18th place, where "1" means "someone." The 19th to 22nd points are the air pressure intensity values.

Bits 23-25 are PM2.5 concentration values. Bits 26-31 are the light intensity values. The 32nd and 33rd bits are check digits. The calculation formula of the check digit is as follows. After dividing each bit of the string by 2, the number of 0 is counted as a check digit.

Figure. 3. Data Sent by the Gateway

$$\text{check digit} = \sum(1 - (\sum(\text{each number mod } 2))) \quad (1)$$

After receiving the gateway data, the server finds the corresponding ID from the database according to the data source information, and splices the RowKey in the HBase. The RowKey contains the source information and time information of the data, and saves the data to the corresponding Key.

5. Software Design

5.1 Automatic Control Function Based on the Internet of Things

Under the premise of intelligent control without data analysis, the system realizes the function of turning off the electrical appliances at night in the sensing layer, that is, inside the classroom. When the time is between 22:00 and 8:00 during the night, and the human body sensor does not sense that there are students or teachers in the classroom, the system will automatically turn off all the appliances in the classroom to save power consumption.

5.2 Data Storage

The storage of data selects the combination of relational database and non-relational database, and combines MySQL and HBase. The following **Figure..** 4 are respectively the E-R graph and database relation graph of MySQL database, which are mainly used to store relational data, for example School information, building information, room information, location information, sensor basic information, equipment installation information, etc.

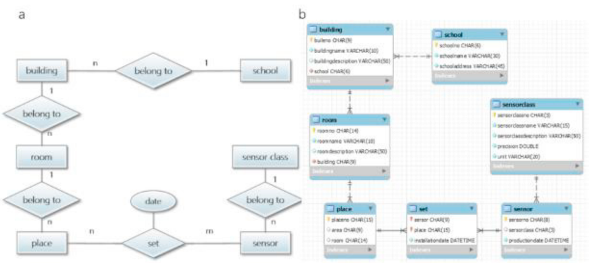

Figure.. 4. (a) E-R Graph; (b) Database Relation Graph.

It is HBase that stores IoT sensor data. HBase provides a single-line scan query for RowKey, a range scan query based on RowKey, and a query scan for tokens. The query efficiency is higher through the RowKey, so the well-designed RowKey has a great impact on the performance of the query [3]. Considering the characteristics of HBase, in this system, "sersorno-placeno-saving time" is selected as the RowKey, and the length of each field in the RowKey is determined to improve the query speed. Environmental parameters include temperature, humidity, smoke concentration, carbon dioxide concentration, gas concentration, human body test results, barometric pressure, PM2.5 concentration, and light intensity as different columns. When querying, the unrelated speed can be avoided and the query speed can be improved.

5.3 B/S-Based School Intelligent Classroom Management System

The school intelligent classroom management system is managed by a website based on the B/S architecture, and the system function structure diagram is shown in **Figure. 5**. The users of the system are divided into school administrators and ordinary users. Each school can set up one or more administrators to manage the equipment and data of the whole school. At the same time, the administrator can add the ordinary users of the school, and the ordinary users can View information and data.

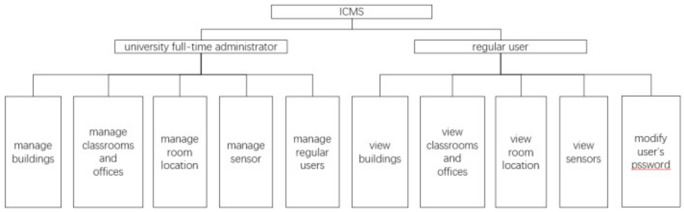

Figure. 5. system function structure diagram

5.4 Data Analysis Visualization Case

The purpose of this system development is to collect classroom environmental data, analyze the use of the classroom, and thus reduce the energy consumption of the classroom. Under the premise of nighttime power outage, during the period from November 20 to April 2019, the system was commissioned in two classrooms 315 and 321 of the Information Technology College (Building 7) of Shanghai Jianqiao College. Excluding the test time of two months, the system recorded a total of more than 69,000 data from January to April 2019. This paper extracts the human body sensor data from March 4th to 8th, 2019 for statistical analysis, and draws the use of 315 classrooms from March 4th to 8th, 2019, as shown in **Figure. 6**. After analysis, it can be seen that March 2019 from 4th to 8th, the usage rate of Class 315 of Building 7 of Shanghai Jianqiao College was 74.43%, of which the time was concentrated at 8:30-11:30 in the morning and 13:00-17:00 in the class. Self-study time from 18:00-21:00 in the evening.

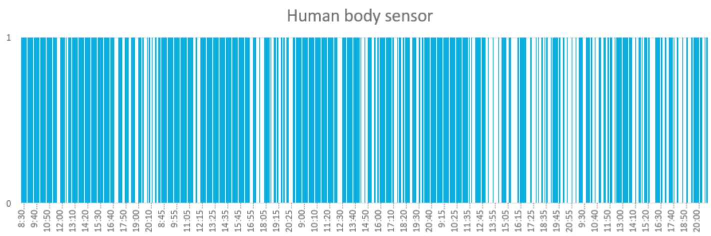

Figure. 6. System Function Structure Diagram

6. Conclusion

This paper develops a low-power, low-cost, easy-to-use, and easy-to-popular system for school smart classroom management. After testing, the storage model based on MySQL and NoSQL can meet the system requirements. MySQL is easy to operate and meets the query rate requirements of small data volume information such as equipment and regions. HBase can provide stable storage and fast data for the massive data generated by the Internet of Things. The reading; during the use of the school intelligent classroom management system, the user can quickly read the data.

In terms of energy utilization, 315 classrooms and 320 classrooms with similar curriculum arrangements during the same week were recorded, of which 315 classrooms were remodeled and 320 were not. In the case of realizing the function of turning off the electrical appliances at night and non-working days, the power consumption comparison is as shown in the **Figure. 7**, and the total energy consumption per week of 320,315 is reduced by nearly

30% compared with the unused system. Under the premise of further intelligent control, energy consumption will be further reduced.

In the next work, the first is to find better indoor Internet of Things solutions to further reduce system energy consumption; the second is to optimize the storage structure and reduce system overhead; the third is to optimize the front-end system, beautify the interface, improve usability and aesthetics.

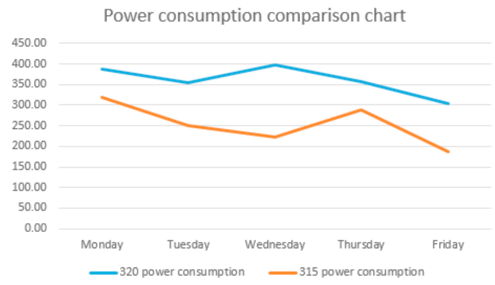

Figure. 7. Power Consumption Comparison Chart

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