The Construction of College Student Management Network Application Platform from the Perspective of "Three-Wide Education"

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Abstract. With the deepening of the construction of digital campus, the new generation of digital information technology and college education and teaching are fully integrated, which brings new opportunities for student management in the new era. In this regard, this paper will put forward a set of construction scheme of comprehensive application platform of student management network based on the problems of poor function expansion and insufficient data sharing ability in the current student management work in colleges and universities, so as to realize the transformation of student management mode. The system takes Web technology as the core, integrates Internet of Things, data mining and other technologies to form specific functional applications, thus providing new management tools and means for student management under the concept of "three-wide education" and promoting the improvement of the student management system in colleges and universities. Practice has proved that RFID technology has obvious advantages in the process of collecting and transmitting students' behavior data, and K-means and other data mining algorithm models deployed on the Web server can complete the analysis and processing of students' behavior, which has played a positive role in improving the efficiency and quality of students' management.

Keywords: student management · Internet of Things technology · data mining · RFID · computer application

1 Introduction

At present, China's economy and society have entered a new period of high-quality development, and the transformation of talent training objectives has put forward new requirements for the quality of teaching management in colleges and universities. In the process of teaching management reform in colleges and universities, students' management methods have been updated, and new management concepts and requirements have begun to appear. In particular, the new ideas and concepts centered on "three-wide education" are constantly being implemented in the practice of teaching management, which has accelerated the upgrading and transformation of the student management model in colleges and universities [1]. In the traditional student management mode, manual mode is still adopted, so the management efficiency is relatively low, and the management

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items and contents are relatively simple, focusing on the teaching process and ignoring the daily life of students. In addition, the information level of college student management is insufficient, the application service lacks expansibility, the data transmission and sharing ability is weak, and there are obvious problems of routinization and rigidity, which can easily lead to resource waste [2]. In view of this, this paper believes that in order to improve the effectiveness of college students' education management, colleges and universities should adhere to the concept of "three-wide education". Combining with the current situation of college students' management, this paper builds a network application platform for college students' management with the practical advantages of the new generation of digital information technologies such as Internet, Internet of Things and data mining, so as to promote the network and digital transformation and upgrading of student management mode and set a new paradigm for college students' management in the new era. The whole system is designed with B/S architecture, and RFID technology is integrated to complete the collection, transmission and storage of students' behavior data. At the same time, with the help of K-means, Apriori and other data mining algorithms, a student behavior analysis and prediction model is designed, which is convenient for teachers and users to quickly master student behavior portraits, thus improving the work efficiency and quality of college student management and making a beneficial attempt for the construction of digital campus.

2 Overview of the Key Techniques

2.1 Internet of Things

Internet of Things (IoT) is a huge data communication system which combines various information sensing devices with the network environment, and can realize the interconnection of people, machines and things at any time and any place [3]. The basic architecture of Internet of Things technology is perception layer, transport layer and application layer from top to bottom. The sensing layer can dynamically monitor and sense the target object or area with the help of sensors, RFID terminals, video surveillance and other equipment, and obtain the corresponding data parameters. The transport layer, also known as the network layer, is responsible for establishing a data transmission path between the terminal of the identification layer and the server to realize the sharing and interaction of data information. The data transmission process can be realized with the help of common local area network, metropolitan area network or wide area network, and the transmission forms used are divided into wired network transmission and wireless network transmission. The application layer integrates many data analysis and processing methods and functional components, aiming at processing data information in an all-round way and exerting the value of data information in corresponding scenarios.

2.2 RFID

Radio frequency identification (RFID) is an important automatic identification technology, which combines the practical advantages of computer application, network communication, wireless radio frequency and other technologies. By using radio frequency

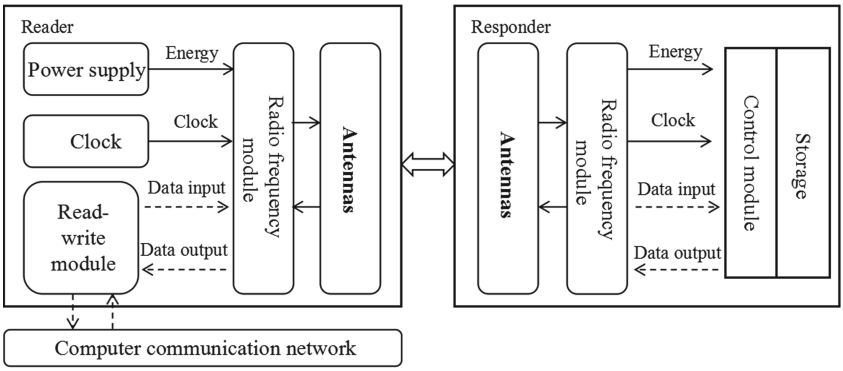

Fig. 1. RFID system composition

signals to automatically identify the target object to obtain relevant data information, it can achieve the purpose of non-contact detection and identification of specific targets [4]. RFID is based on wireless communication system, which contains many electronic components such as tag, antenna, transmitter, receiver and microprocessor. Figure 1 shows the basic structure of the RFID system. The workflow of RFID consists of four steps. First, the reader sends out a radio frequency signal with a specific frequency via an antenna, and when the transponder enters the effective induction area, it automatically generates an induced current and obtains the corresponding energy to activate the transponder. Secondly, the transponder sends the coded information in its own memory through its own radio frequency antenna. Then, after the reader receives the signal sent by the transponder, it is decoded and recognized by the read-write module to obtain the corresponding code and information. Finally, the reader transmits the obtained data information to the server through the computer communication network to complete the data storage and processing [5].

In practical application, RFID system can be classified into different categories according to its working frequency. For RFID system, the frequency of radio frequency signal is the working frequency, which is a key index parameter that determines the application scenario and operating cost of the system. As shown in Table 1, it is the conventional frequency classification and typical applications.

2.3 Development Process

First of all, in the aspect of hardware equipment selection, RFID sensing system is comprehensively considered from three aspects: reader, transponder and application development platform according to the actual situation of campus and the application requirements of student management network application platform. RFID reader adopts UHF BRD-04 four-channel fixed intelligent reader and is installed in different areas such as canteens, libraries, teaching buildings and dormitories on campus. The choice of transponder will give full play to the users of modern smart phone terminals, with RFID-SIM card as the electronic tag. As a passive tag, RFID-SIM can not only support the basic mobile communication function, but also carry out near field communication through

Table 1. RFID system operating frequency

Operating frequency	Frequency range	Typical application	Feature
Low frequency	30–300 kHz	125 kHz, 133 kHz	Passive tag, high penetration, small range and low cost
High frequency	3–30 MHz	13.56 MHz	Passive tag, anti-collision, high data transmission rate
Ultrahigh frequency	≥300 MHz	433 MHz, 860 MHz	Passive and semi-active tags, synchronous identification and wide range

RF chip, antenna and reader, so as to realize the functions of identity authentication, attendance and consumption. For the application development platform, according to the API interface supported by the reader, the reader connection method, data reading method and input/output port are set. BRD-04 four-channel fixed intelligent reader-writer can support Ethernet, RS-232, RS-485, USB Host & Device, Wi-Fi, Bluetooth, multiple communication interfaces, and the tag identification speed is set to ≥500 times/s, and the output power range is set to 0 dBm–33 dBm [6].

Secondly, the basic framework of the platform is built according to the B/S architecture, and is divided into three parts according to the established hierarchical system: presentation layer, business logic layer and data layer [7]. According to the actual requirements of this system, the framework of Spring 5.2.2 and MyBatis 3.5.2 in Java language environment and Apache Tomcat 9.0 are selected to complete the server-side configuration. In addition, the bottom operating system of the platform is Windows Swever Standard, the JDK version is 1.8.0_251, the integrated development tool is Eclipse Neon 4.6.2, and the database server is MySQL 5.7.

In addition, for the analysis and processing of students' behavior data, it is necessary to complete the construction and training of various data algorithm models in advance, and deploy them on the platform Web server. When the user sends a call request through online interactive operation, the Web server responds and completes business logic control, and the final result is displayed in a visual chart. Through the overall environment of the above system development and the configuration of related software and tools, the technical feasibility of the college student management network application platform is also clarified.

3 Functional Implementation

3.1 Student Attendance Management

The core application of college student management network application platform lies in the identification of the location and moving path of student users by RFID system. The basic principle is shown in Fig. 2. In the process, the concept of analog channel is introduced, that is, when a student user enters a building or place on campus, the path he passes through forms a rectangular area. Two RFID readers are installed in the two

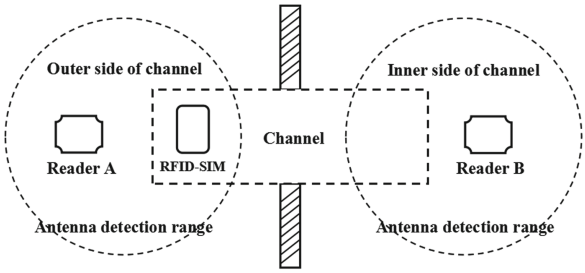

Fig. 2. RFID system's perception of students' position and moving path

channels respectively, and the detection ranges of the antennas do not cross. The platform judges whether the student user enters or leaves this position through the time sequence when the readers detect the RFID-SIM card in the student user's mobile phone.

The RFID-SIM card contains students' personal information. When the RFID-SIM card enters the detection range of the reader's antenna, it will automatically acquire the clock and energy and send relevant data to the reader. Within the platform, teachers and users can check the time of students entering the teaching building or classroom under this function module, and compare it with the normal class time, so as to obtain the attendance results of students. Similarly, relying on the convenience of RFID sensing system, the platform can bring stadiums, dormitories and laboratories into the scope of attendance management, forming a multi-dimensional attendance management system.

When the college student management network application platform realizes the student attendance management, it needs to ensure the integrity and correctness of the signal transmission in the identification communication process of the RFID system, especially when the students in the campus are dense, and the interference of electrical signals in the environment and the repeated occupation of channels are the main reasons for the unbalanced signal transmission [8]. Facing the problem of unbalanced signal transmission, the platform will integrate TDMA method, that is, use ALOHA anti-collision command to reduce information conflict. Common ALOHA anti-collision commands include pure ALOHA, slotted ALOHA and frame slotted ALOHA. Pure ALOHA is driven by the RFID-SIM card of the student user. When the student user enters the detection range of the reader, all RFID-SIM electronic tags randomly generate a back-off time, and then send data information according to the back-off time. If there is no conflict in the sending process of all electronic tags, they can all be recognized by the reader. Otherwise, the conflicting electronic tags will continue to generate new back-off time and send it again until the electronic tag is successfully detected [9]. Figure 3 shows the working principle of pure ALOHA, in which the time for an electronic tag to send a frame of data is T_0, the network load is g, that is, the average number of frames sent in T_0, and the throughput S is the average number of successful frames sent in T_0. The relationship between throughput and network load is shown in Formula 1, and P is the probability of successful transmission in any T_0 period.

$$S = G \times P = G \times \frac{(2G)^0 e^{(-2G)}}{0!} = Ge^{-2G} \tag{1}$$

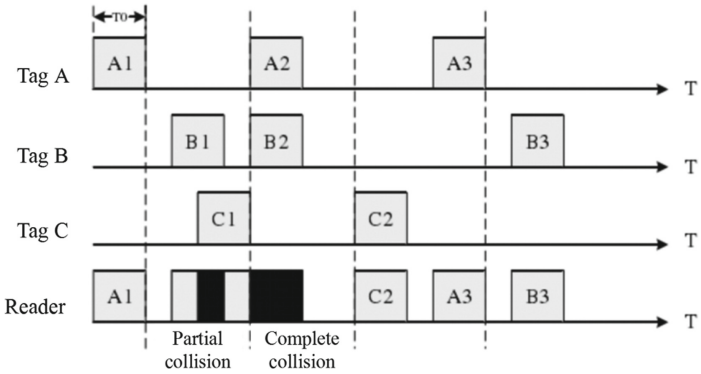

Fig. 3. Working principle of pure ALOHA

Compared with pure ALOHA, slotted ALOHA can preset equidistant time slots, and all electronic tags send according to time slots completely, thus avoiding the partial collision problem of pure ALOHA and improving the working efficiency of pure ALOHA. Formula 2 shows the relationship between throughput and network load in slotted ALOHA. The simulation results of pure ALOHA and slotted ALOHA under the same number of electronic tags are shown in Fig. 4. Experiments show that pure ALOHA, that is, P-ALOHA, has a maximum throughput of 18.39% when the network load is 0.5. The throughput of slotted ALOHA, that is, S-ALOHA, reaches the highest of 36.79% when the network load is 1, and the overall performance is better than that of pure ALOHA.

$$S = G \times P = G \times \frac{G^0 e^{(-G)}}{0!} = Ge^{-G} \tag{2}$$

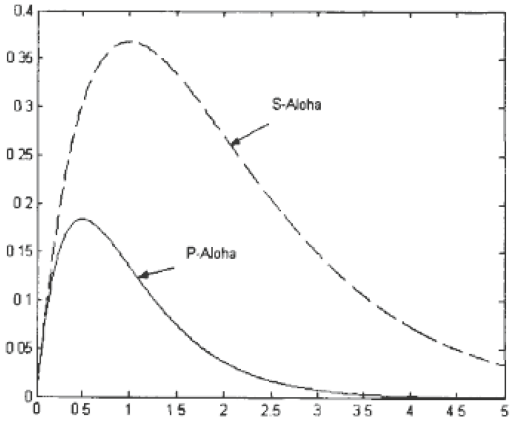

Fig. 4. Comparison of simulation effects between pure ALOHA and slotted ALOHA

3.2 Data Analysis

RFID-SIM can meet the requirements of radio frequency identification, but also has the functions of consumer payment, identity authentication and so on, and contains more data information. The application platform of college student management network can collect and store all kinds of behavior data of student users on campus by relying on RFID system, and combine with traditional teaching management data information to form a multi-dimensional portrait system of student users. In the face of massive student data information, the platform will use SVM, Adaboost, K-means and other algorithm models for analysis and mining, so as to further provide strong decision support for student management and campus governance. Taking K-means clustering algorithm as an example, this paper classifies students according to the original data of various behaviors, and forms a certain student group, so as to obtain the characteristics of group students' behaviors. As shown in Table 2, it is the original data of students' behavior, and the data is counted according to the detection times and detection time of RFID-SIM.

In the K-means analysis, the original data of student users will be feature-extracted, and seven features such as teaching building, library, canteen, dormitory, book borrowing, attendance rate and grades will be selected for cluster analysis, and the value of cluster center point c_k will be calculated according to SSE formula, as shown in Formula 3. Among them, the original data set is $D = \{x_1, x_2, x_n\}$, and after clustering, the category set is $C = \{C_1, C_2, C_n\}$, and c_k is the center point of cluster C [10]. The final clustering result obtained by calculation is shown in Table 3, and the number of clusters is determined to be 5 according to the change of contour coefficient. The cluster scatter plot drawn for grades is shown in Fig. 5.

$$SSE(C) = \sum_{k=1}^{K} \sum_{x_i \in C_k} \|x_i - c_k\|, c_k = \frac{\sum_{x_i \in C_k} x_i}{|C_k|} \tag{3}$$

According to the results of cluster analysis, the students of Type 0 have excellent grades, and the attendance rate is the highest in teaching buildings, libraries and dormitories, and the number of occurrences of canteens and dormitories also conforms to the normal work and rest rules, with a positive overall state and strong learning motivation. Type 1 students' grades are at a good level, and the number of teaching buildings and libraries has decreased, but the number of dormitories has increased. It is speculated that

Table 2. Raw data of students' behavior (part)

Student ID	Name	Teaching building	Library	Canteen	Bathhouse	Supermarket	Gym	Dormitory	…
001	wang	225	103	375	59	37	16	151	…
002	zhang	194	67	304	65	118	35	139	…
003	xiao	81	133	317	88	134	9	127	…
…	…	…	…	…	…	…	…	…	

Table 3. The clustering results

Type	Result	Teaching building	Attendance rate	Library	Book borrowing	Canteen	Dormitory
0	Excellent	231	95.31%	311	63	338	151
1	Good	194	83.15%	231	37	297	187
2	Ordinary	138	69.51%	134	19	168	211
3	Relatively poor	119	60.37%…	87	9	97	174
4	Poor	97	58.47%	46	5	139	184

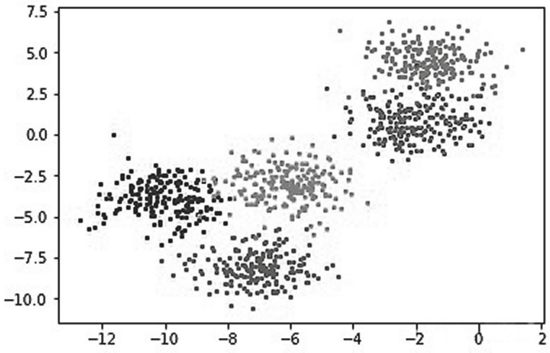

Fig. 5. Scatter plot of the cluster analysis results

such students are more curtilage. Type 2 students' overall characteristic values are in the middle state, with average grades and irregular diet, and may rely more on take-out and lack learning motivation. Type 3 students' grades are poor, and they are not frequent in canteens and dormitories. It is speculated that such students have other hobbies or have part-time jobs outside school. Type 4 students' grades are poor, and the frequency of canteen and dormitory is similar. It is speculated that students may have certain economic difficulties or practical problems, and teachers need to intervene to understand.

4 Conclusions

In order to improve the work mode of college student management, this paper aims at many shortcomings under the traditional management mechanism, and builds a college student management network application platform with the help of the practical advantages of Internet of Things technology, data mining technology and computer application technology. The platform focuses on the collection and transmission of students' behavior data by using RFID system, which realizes the multi-dimensional supervision of students and sets a new paradigm for the management of college students in the new era. In the follow-up research, it is necessary to further improve the detection accuracy

and adaptability of RFID technology, enhance the abundance of student management projects, and make contributions to the current digital education reform in colleges and universities.

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