Design of Student Attendance System based on 2.4Ghz RFID Technology

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Abstract. In order to improve school management of student attendance, based on the 2.4Ghz card, using RFID technology and server back-end technology, A set of student entry and exit attendance system has been designed. The current positioning method generally used distance fitting model based on RSSI. This method has very high accuracy, but the accuracy of calculation results is highly affected by the environment and the amount of data required for calculation is very large. Usually, the data need to be transmitted from the terminal to the server for processing which increases calculation complexity. The paper proposes an algorithm based on least squares semaphore, this algorithm greatly simplifies the calculation complexity and improves the calculation efficiency.

1. Introduction
Some studies indicate attendance is an important content in the management of school affairs. The attendance of entering and leaving the school has the top priority of the entire attendance (Zhou Kehui). The statistics of student entering and leaving the school not only affect the daily disciplinary management, but also is to be conducive to guaranteeing personal safety of students. Therefore, every school attach great importance to the attendance of students entering and leaving school. At present, there are mainly the following problems [1-2]:

1. Base on student cadre on-duty system, Student union officer count the number of student who entering or leaving school at the specified time, and report the statistics to the head teacher. The head teacher confirms the number of absentees and publish list of absentees based on the statistical results. This method is time-consuming and labor-intensive.

2. LU S.P. Zheng M and Wu Y.H have proposed method to check attendance based on 13.56M cards. The attendance system automatically counts the number of students entering or leaving the school. However, there is a problem about insufficiency of attendance equipment when students are entering or leaving the school at the same time which will cause students to be overcrowded at school gate and cause student safety risk [3-4].

Next I will describe a whole new attendance system based on 2.4Ghz and propose a new algorithm based on least square method and I will show you the query interface of the system.

2. Design of entry and exit attendance system based on 2.4Ghz
Based on comprehensive analysis of the above problems, we can clarify that the key point of the problem is how to obtain statistics on the number of students entering and leaving the school gate quickly and accurately within the specified time and there is no need for students to queue up and check their cards for entering or leaving school. The non-contact IC card is used to design the
attendance system for students entering and leaving the school. 2.4G active card have much advantage, such as contact-free, long reading and writing distance, high reliability, strong real-time performance, and encryption performance. It has been widely used in logistics management, road management, attendance management etc. 2.4G active card reading and writing distance can be over 20 meters. Considering that the width of most of the current school gates is less than 10 meters, the 2.4G active card can meet the system requirement far enough[4].

2.1 Design of hardware system
The system mainly includes the following parts: 2.4G reader, smart terminal, card issuer, backend server, etc. The specific structure diagram is show by figure 1.

![Figure 1. Structure diagram of system hardware](image1)

2.2 System flow
System flow is show by Figure 2.

![Figure 2. System flow](image2)
(1) Obtain the 2.4G card ID number by using the card issuer to read card number, and directly bind the number with student's name, ID and other information, which will be stored in the backend server.

(2) When student who wearing 2.4G activated card entering or leaving school, the 2.4G reader reads the student card number and sends the card number to the smart terminal. The smart terminal uses the algorithm proposed in this paper to determine the entering or leaving school status of the student who is wearing 2.4G activated card, and transmits the status information with card number through the wireless transmission module to the student information background server.

(3) Teachers and parents can check the entering and leaving status of students through the web or mobile APP.

3. Entering and leaving attendance algorithm design of smart terminal

Propagation model method and the received signal strength indicator (RSSI) location algorithm based on RFID has been commonly used. The location model based on RSSI has a good positioning effect and is easy to be deployed, so it is one of the current research hotspot [5]. This article uses a signal strength algorithm based on least squares based on actual application. Entering and leaving school algorithm based on RSSI Least squares which mainly include two parts, time-RSSI normalization, and data processing [6].

3.1 time-RSSI normalization

When students entering and leaving school, we should configure the RSSI reception threshold of the reader to ensure that the signal from the student card can be only collected when the student is close to the school gate. The time and signal strength of one student's card which can be received by reader 1 are defined as Timer11, RSSI11, Timer12, RSSI12…Timer1i, RSSI1i…Timer1n, RSSI1n, received by reader 2 are defined as Timer21, RSSI21, Timer22, RSSI22…Timer2i, RSSI2i…Timer2n, RSSI2n. As shown in table 1.

| Reader | Reader 1 | Reader 2 |
|--------|----------|----------|
| Time   | Timer11  | Timer21  |
| RSSI   | RSSI11   | RSSI21   |

The receiving time Timer11 and Timer21 are normalized to data from 0 to 65535, and RSSI11 and RSSI21 are normalized to 0 to 255.

3.2 Data Process

The RSSI (received signal strength indicator) processing includes the following methods, such as Euclidean distance, probability distribution, neural network, support vector machine etc. which are basically based on the logarithmic model. The specific expression is as follows:

\[ RSSI(d) = RSSI(d_0) - 10n \log \left( \frac{d}{d_0} \right) + X \]  \hspace{1cm} (1)

Where RSSI (d0) is reference path loss, n is path loss index and X is normal random variable of standard deviation. According to the expression (1), the distances which determine the student's entering and leaving status can be obtained. This method is extremely affected by environmental change and needs higher computational cost. This article uses the least square method to calculate the RSSI extreme value, and the expression is as follows:

\[ \sum_{i=0}^{n} \epsilon_i^2 = \sum_{i=0}^{n} \left[ \varphi(x_i) - f(x_i) \right]^2 \]  \hspace{1cm} (2)

According to the expression(2), the distribution value of the maximum RSSI (received signal strength indicator) and the corresponding Timer values T1_max and T2_max can be obtained which is
shown in Figure 3.

\[ \text{Reader 1} \quad \text{Timer} \quad \text{Reader 2} \]

\[ \text{RSSI1} \quad \text{RSSI2} \]

\[ \text{T1}_{\text{max}} \quad \text{T2}_{\text{max}} \]

**Figure 3.** Algorithm simulation diagram

It can be seen $T1_{\text{max}}$ is less than $T2_{\text{max}}$ from Figure 3, which indicate that student's path is from reader 1 to reader 2. According to the reader's position, it can be judged whether the student wearing this card is entering or leaving school.

4. **Information query interface**

Data table of attendance in the morning for the primary six (5) class of XX school is shown in Figure 4

**Figure 4.** Information query interface
As shown by figure, the query interface is so clear to show the attendance information which proves the rationality of the system and the effectiveness of the algorithm.

5. Conclusion
This article introduces the attendance system based on 2.4G RFID card for students entering and leaving the school, and this system has been used in many schools, and has runned stably and efficiently for a long time. A RSSI algorithm based on the least square method is proposed, which can quickly determine the status of student's entering or leaving school on smart terminal, which greatly reduce the difficulty data processing on background and hugely reduce the cost of the entire system. Also we can improve the hardware design to make the installation easier.

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