

Management information system for college track and field games on the basis of infrared radio-frequency technique

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Abstract

College track and field sports involve numerous participants and events. Moreover, recording and announcement jobs are complex. The requirements for accuracy and precision are high. The traditional manual management mode cannot adapt to development needs. Based on the advantages of Radio Frequency Identification (RFID) such as no-barrier read, remote penetration, speed scanning, large memory space, anti-pollution capacity, durability, diversified shapes, reusability, and good security, an RFID-based infrared radiofrequency technique is designed to achieve automatic identity verification for athletes and to construct a complete score management information system. An automatic check mode is used to identify athletes by combining an ID card, a card reader, and a computer. This mode can rapidly identify the personal information of athletes and prevent cheating. This system has important significance for improving management level and reducing manpower.

Keywords: RFID, track and field games, management information system, card reader

1 Introduction

Radio Frequency Identification (RFID) uses inductive space coupling (inductive or electromagnetic coupling) to automatically identify objects [1]. RFID is a non-contact automatic identification technology. This technology can identify specific objectives through a radio signal, and read and write relevant data without mechanical contact or optical contact between the identification system and the specific objective [2]. Common techniques include low frequency (125 k–134.2 k), high frequency (125 k–134.2 k), super high frequency, and microwave. In this study, infrared light is selected as the radio frequency signal source [3]. Common barcode technology has unparalleled obvious advantages in the following aspects: amount of information, read-write capacity, confidentiality, intelligence, photopathy, environmental adaptation, speed identification, running speed, reading distance, service life, and multi-tag identification [4]. RFID technology is used to achieve the fully-automatic management of college track and field sports; it is used to construct an automated score management information system, which can simplify management process and improve management efficiency [5].

Track and field is an important means to improving health [6]. Many methods and means in track and field sports are adopted by other sports and serve as the main means to improving athletic performance and promote metabolism, improve the functions of visceral organs, and comprehensively develop physical quality [7]. Track and field is an effective way to inspecting the effects of the

proposed system. In various track and field sports, grassroots track and field sport has the strongest fundamentality and the widest generalization performance [8]. Given that national fitness consciousness is continuously increasing, physical education for college students enters a period of rapid expansion [9]. College track and field sport as an important link in college physical education is characterized by numerous participants and events, complex recording and announcement work, and high accuracy and precision [10]. College track and field sports are traditionally managed manually or artificially. Such management mode involves heavy workloads and a large amount of manpower. Moreover, errors may easily occur [11]. Thus, it cannot meet the requirements of college track and field sports.

The advantages of RFID (such as no-barrier reading, remote penetration, speed scanning, large memory space, anti-pollution capacity, durability, diversified shapes, reusability, and good security) have received much attention from many fields [12]. This study analyzes college track and field sports to confirm the functional objectives of this system as well as to design functional software, select hardware, and complete the design of score management system for college track and field sports.

2 RFID

2.1 RFID SYSTEM COMPOSITION

Given that RFID systems have different applications, their compositions also differ. Typical FRID is mainly

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composed of an e-tag, a reader, RFID middleware and application system software. Table 1 shows the functions of each part and their composition.

TABLE 1 RFID system composition

Composition	Function	Composition
E-tag	Identify objects/articles; own data storage mechanism; capable of receiving electromagnetic field modulating signal of the reader and return data carrier of corresponding signals	Active tag and passive tag; low-frequency/high-frequency/superhigh-frequency e-tags; active/semi-active/passive tags
Reader	The device writes or reads data for RFID tags through radio-frequency coupling	Carries out the read-write function through integrated or split-type antenna
RFID middleware	Hardware management, data collection, data processing and data transmission; the "nerve center" of RFID systems	The software that connects RFID hardware, leads and controls data collection, filtering, and application; between RFID devices (reader and labeling machine) and backend application system
Application system software	Control coordination work of the tag and reader through middleware; processes all data collected using the RFID system; computes, stores, and transmits data	Application software developed according to the specific needs of different industries; can effectively control the reader when reading and writing e-tag information; carries out concentrated statistics and processing of target information collected

2.2 REALIZATION PROCESS OF RFID SYSTEM FUNCTIONS

When the tag enters the radiation range of reader aerial, it receives the radio-frequency signal sent by the reader. The passive tag sends the data stored in the tag chip through the energy gained from induced current; the active tag actively sends the data stored in the tag chip. The reader is generally equipped with middleware with certain functions. The middleware can read data, decode, directly perform simple data processing, and send the data to the application system. The application system judges the legality of the tag according to a logical operation and conducts corresponding processing and control in allusion to different settings.

3 Design of score management system for track and field athletics

3.1 ANALYSIS OF CUSTOMER BASE DEMAND OF SCORE MANAGEMENT SYSTEM FOR TRACK AND FIELD ATHLETICS

The main customer base of the score management system for track and field athletics includes athletes, in-charge persons of each department, referees, and management

committees. System demand analysis for each type of users is shown in Table 2.

TABLE 2 Demand analysis for each type of customers of track and field athletics

Customer composition	Customer demand
Athletes	Registers, competes, and inquires about the scores
In-charge persons of each department	Athlete registration management; submit registration information to the management committee
Referees	Types in, modifies, and inquires about the cores of the items
Management committee	Works before the application: prepare sport events, sets competition schedules, sets competition events, divides the work between referees (1) Before the competition: athlete information entry, grouping, competition schedule preparation, preparing and printing the competition sequence (2) In the competition: athlete registration, score input, score modification (3) After the competition: competition result announcement, score printing, prize presentation

3.2 OVERALL DESIGN OF SCORE MANAGEMENT SYSTEM FOR TRACK AND FIELD ATHLETICS

3.2.1 Overall system objective

The overall system objective is to realize computer-automated management of college track and field sports, establish a perfect track and field athletics management system, change semi-labor management to computer automated management, and realize the following functions: athlete information tracking, automatic pre-competition reminding, historical score comparison, automatic score release, etc.

The development of this system can free athletes, in-charge persons of each department, referees, and management committees from heavy repeated data entry and statistics, realize information network sharing, and lay the foundation for information automation.

3.2.2 Functional design

According to customer demand analysis and the overall system objective mentioned above, the score management system mainly achieves the following functions: user management, athlete information management, score management, and database management, as shown in Table 3.

TABLE 3 Design of main functions of management system

Function	Object	Inclusion
User management	System administrator	Maintains uniform management of the management system customer base; maintains software security and stability
Athlete information management	In-charge persons of departments, management committees	Adds, modifies, and deletes personal information of athletes
Score management	Referees, management committees	Inputs, modifies, deletes, and publishes, scores
Database management	System administrator	Inputs current useful data; calls out of the database; maintains data security

In traditional college track and field sports, due to laggard means, athlete registration, i.e., personal information checking before the competition and score input after the competition, takes much time.

1) Athlete registration before the competition. This activity gives referees a very heavy workload and long waits also affect the state of athletes. Moreover, traditional registration modes cannot effectively prevent cheating, which affects competition fairness. In such case, RFID-based automatic registration can greatly shorten registration time as well as effectively prevent cheating and ensure competition fairness.

2) Post-competition Score management. In the traditional score input mode, referees must first confirm the list of athletes according to the scores and then input the data, a process that consumes much time and energy.

If athletes can be automatically identified, pre-competition registration and post-competition score input will be very simple. The following processing can be carried out:

1) Before the sports meeting starts, according to athlete information submitted by each department, the management committee uniformly manages athlete information. The information includes the name, ID number, gender, department, grade, photo, etc., of the athletes.

2) Before every competition, the administrative staff calls out the information of the athletes participating in this competition and inputs their IC cards based on RFID technology. Before registration, IC cards are distributed to athletes participating in registration.

3) During registration, the athletes wear the IC card at the registration site and the card reader is used for identification. Through scanning the IC card, the computer displays the registration information of the athlete including the photo. The referee can directly contrast the photo for registration and judge for consistency and cheating behavior.

4) When the competition is over, the card reader reads the IC card of the athlete. Then, the referee can complete score input.

After the competition is over, ID cards are collected uniformly. They can be used in the next competition again according to the above process. The specific application process is shown in Figure 1.

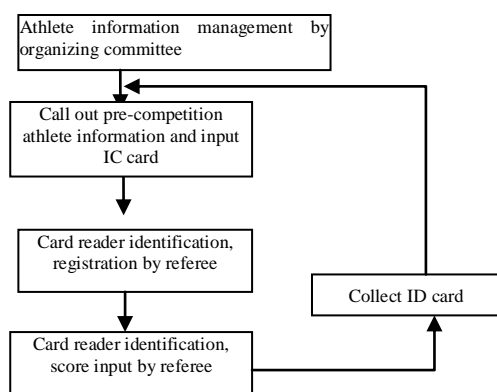


FIGURE 1 RFID-based ID card automatic athlete identification and application process

3.2.3 Network design

RFID uses a radio-frequency signal, space coupling, and the transmission characteristics of radio frequency signal to automatically identify static or mobile articles and data exchange. This technology uses a radio frequency to conduct non-contact both-way communication for identification and data exchange. Thus, the network design of track and field athletics site is also an important link of this management system.

Usually, optional network types include Wireless Local Area Network (WLAN) and wireless LAN.

LAN connects computers distributed in different places in the specified range. Using network software, computer resource sharing or communicative network system can be realized. Wired LAN usually uses copper wire or a cable as the main transmission medium of computer networking.

WLAN is the extension of fixed LAN that uses radio frequency technology to connect to a network without being limited by a cable and replaces traditional LAN made using twisted-pair copper wire. For users, it is completely transparent. Users can clearly establish the network meeting their demands according to the simple architecture of WLAN.

TABLE 4 Design of main functions of management system

Type	Advantages	Disadvantages
Wired LAN	Work stably; fast communication speed	Fixed place, complex wiring. Complex work
WLAN	Move flexibly; easy to extend; convenient to use; easy to plan and adjust	Unstable signal, poor communication quality

Through comprehensive consideration, wired LAN and WLAN are combined to construct the overall network of the score management system.

Wired connection: 1) LED large screen and control computer; and 2) control computer and score input computer.

Wireless connection:

- 1) control computer and registration computer;
- 2) RFID card reader and registration computer; and
- 3) RFID card reader and score input computer.

The wired network connection depends on planning for wiring to completely establish a wired network. Wireless network establishment is based on the school wireless network. The router is set up based on the original wireless network to establish LAN. Through LAN settings, the computer on the platform is set to the mainframe to realize information sharing between the mainframe and extension. Thus, the mainframe can obtain competition information, which is convenient for comprehensive organization and uniformly printing information for sports meetings.

3.2.4 Analysis of system design rationality

After the system objective setting, functional design, confirmation of the ID card identification process, and

network design are completed, the Delphi method is used for opinion collection and modification to ensure effective and rational system design. The Delphi method uses predicted questions and background materials to create objective and scientific questionnaires, which are sent to the experts through door-to-door delivery or mail. The experience and knowledge of experts are used to make predictions. Through synthesis, concluding, and much feedback, opinions can basically remain consistent to improve the accuracy of predictions.

This study chooses 20 people including physical exercise experts, large-scale competition organizers, management experts, and software scholars to fill in the questionnaires, as shown in Table 5.

TABLE 5 Interview expert composition

Type	Title	Number	Proportion
Physical exercise experts	Associate professor	7	35%
Large-scale competition organizers		6	30%
Management experts	Professor	4	20%
Software scholars	Associate professor	3	15%

Expert consultation is divided into three rounds. Questionnaire collection and statistics are shown in Table 6.

TABLE 6 Results of expert consultation

Round	Number of questionnaires not collected	Number of questionnaires connected	Number of questionnaires issued
The first round	2	18	20
The second round	1	19	20
The third round	2	18	20

The questionnaire evaluation experts of 20 experts are shown in Table 7.

TABLE 7 Results of expert evaluation

Type	Effective	Basically effective	Invalid
Number	4	16	0

Table 6 shows that, to experts, the functional design of this management system is basically effective and rational. They also find that it can be used for score information management in college track and field sports.

4 Realization of information management system software for track and field athletics

4.1 DEVELOPMENT TOOL AND TECHNOLOGY

ASP.NET operates on Windows platforms under the .NET framework. It is a part of the Microsoft .NET strategy and mainly promotes the technology of Microsoft.

ASP.NET is completely based on modules and components. ASP.NET has good expandability and customizability. It is established on the basis of CLR (Common Language Runtime), and mainly used to develop Web applications with strong functions in the server.

As a part of NET Framework, ASP.NET can use all services provided by this framework, including networking, data access, security, and other services. Thus, ASP.NET can create richer Web application programs and constructs building blocks needed by the application program conveniently and swiftly the logic of the application program can be focused on. Visual Basic 6.0 (vb6.0 download) is an event-driven programming language developed by Microsoft. This software includes assistance development environment. VB has the largest number of users. VB6.0 is derived from BASIC programming language. Visual Basic 6.0 has a graphical user interface (GUI) and a rapid application development (RAD) system. Thus, it can easily use DAO, RDO, and ADO to connect the database or easily create ActiveX control.

This study comprehensively applies VB language and ASP.NET technology for the management information system software for track and field athletics.

4.2 OVERALL BLOCK DIAGRAM OF SYSTEM SOFTWARE

System software design is the core content of the whole information management system for sports meetings. The system must complete backstage management interface and system functions must be completed. Thus, software design is an important constituent part of a system. VB language was selected to program the system software. Three major contents are included: backstage management, identity identification, and data information management. The overall block diagram of system software is shown in Figure 2.

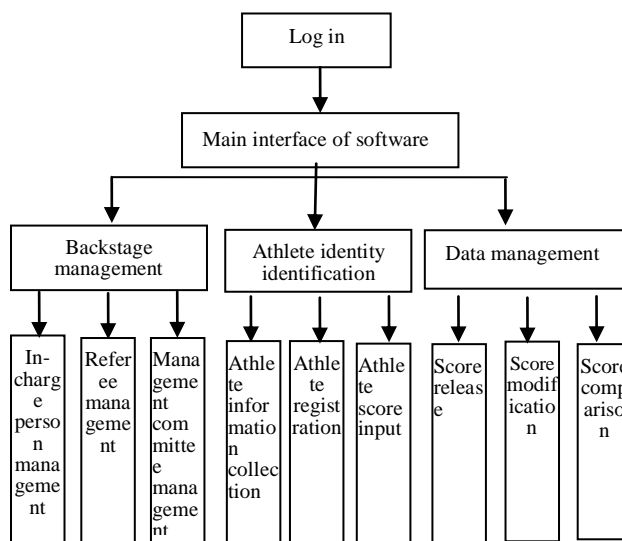


FIGURE 2 Overall block diagram of system software

4.3 REALIZATION OF USER LOG-IN FUNCTION

Use log-in process is shown in Figure 3. Specific codes written by VC are as follows:

```

Set adoRS = New Recordset
adoRS.Open "SELECT * FROM user where user name=" &
Text1.Text & "", db, adOpenStatic, adLockOptimistic
If adoRS.EOF Then
    Label4.Caption = ""
Else
    If Text1.Text=""Then
        Label4. Caption = adoRS.Fields("privilege")
        If Trim(Text2.Text) = adoRS.Fields("password")Then
            Unload Me
            db.Close
            MDIForm1.Show
        Else
            MsgBox " wrong password"
            Text2.Text = ""
        End If
    End If
End If
    
```

If user information has been added in the corresponding user database, users can log in through the above process. After new user information is added, the following codes can be used to timely update backstage database, such that new users can promptly log in. The code is as follows:

```

Adodcl.ConnectionString
"Provider=MicrosoftJet.OLEDB.4.0;Persist Security
Info=False;Data Source=" & App.Path & "\name.mdb;Jet
OLEDB :Database Password=abc;"
Adodcl .RecordSource = "SELECT * FROM user"
Adodcl .Refresh
MSHFlexGndl.Refresh
    
```

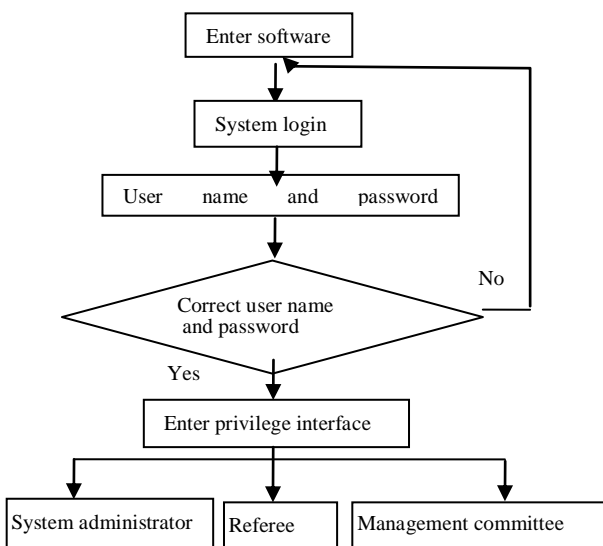


FIGURE 3 Flow diagram of user login function

4.4 REALIZATION OF ATHLETE IDENTITY IDENTIFICATION FUNCTION

Athlete identity identification is the core of the whole management system and was realized through the mutual recognition of IC card and card reader, wireless network connection to the computer, and data transmission. The reader serves as the slave computer, whereas the computer serves as the principal computer. The two conduct serial port communication through a RS-485 serial port.

Before the serial port is used for communication, an initialized setting of the parameters of the serial port is needed: the communication port number must be selected and the size of the buffer, the number of characters of the transmission buffer, the parameters of Baud rate, odd-even check, data bit, and stop bit must be set. The specific process is shown in Figure 4.

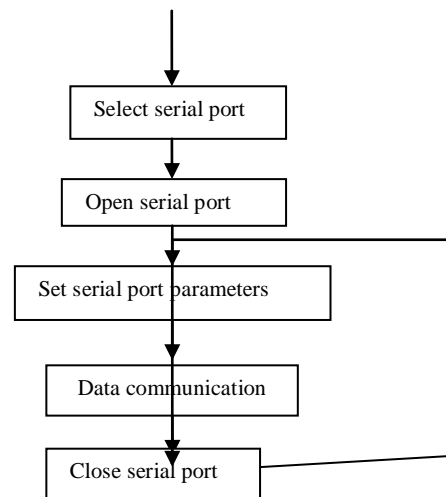


FIGURE 4 Flow diagram of serial port communication

The realization of specific codes is as follows:

```

MSComm1.CommPort = 1 //set COM1
MSComm 1 .Settings = "9600, N, 8, r"
MSComm 1.InputLen = 0// tell the control to read the whole buffer
MSComm1 .PortOpen = True //open serial port
MSComm1.RThreshold = 16 // set to receive a byte to generate OnComm event
//Rem judge whether communication port is open (used in the button of "open serial port")
If MSComm1 .PortOpen = False Then
MSComm1 .PortOpen = True //open communication port
If Err Then
// error handling
MsgBox "invalid serial port communication"
End If
    
```

4.5 REALIZATION OF SYSTEM PRINTING FUNCTION

The main functions of print module include printing athlete files for each event, competition results of each event, department scores and total scores, as well as competition arrangements. To realize this function, the score management computer is connected to the printer. The code is as follows:

```
Printer.Print
```

The system interface also has other functions, such as introducing competition rules of the sports meeting, which are not difficult to realize. We can click the toolbar button and apply VB code to connect the interface and WORD document and then click the event code of the button:

```
Dim wordObj
Set wordObj = CreateObject("Word.Application") //create a word object
With wordObj.Documents.Open("C:\Documents and Settings\Administrato\ desktop\sports meeting new \new\ sports meeting rules.doc")
End With
```

5 Hardware design for score management system of track and field athletics

The hardware architecture of score management system for college track and field sports is shown in Figure 5.

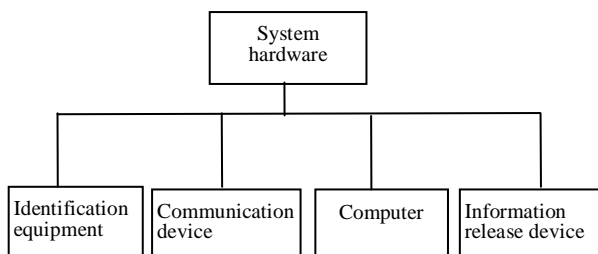


FIGURE 4 System hardware architecture

The card reader is a main part of the identification equipment and connects ID cards to the computer. EM-100T radio-frequency card reader is selected. EM-100T is a non-contact radio frequency IC card reader with a working frequency of 125kHz. The embedded microcontroller is designed with a radio-frequency receiving line and receives a 64-bit compatible ID card uin4100

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combined with a decoding algorithm. The microcontroller has high receiving sensitivity, a small working current, and a single DC power supply.

Technical parameters of EM-100T are as follows:

Working frequency: 125 kHz

Working voltage: 9 VDC

Working current: 200 mADC

This system uses a close-loop wrist-strap ID card, which has high resilience and is easy to wear without affecting athlete performance. The watch-shaped card includes a non-contact chip that can send infrared signal to identify the athlete.

The hardware list for constructing the whole system is as follows: 4 computers including 1 host computer, 1 computer for releasing information, and 2 computers for registration; a large LED screen located on the platform of the sporting meeting; 8 card readers including 2 fixed-type card readers and 6 handheld card readers; 80 watch-type ID cards; and extra 20 IC cards for standby applications. The hardware list is shown in Table 7.

TABLE 7 Results of expert evaluation

Hardware equipment	Quantity
Computer	4
LED	1
Card reader	8
ID card	100
Router	4
RS serial port	2

6 Conclusions

This study uses college track and field sports as an example. Then, it starts from practical application and combines RFID technology, database technology, and network technology to establish a RFID-based sport information management system. This study focuses on the features of college track and field sports, such as numerous competition events, many athletes, tight time and heavy workload, and proposes an automatic checking mode for athlete identification combined with ID cards, an card reader, and a computer. Given that RFID technology is unique, it can rapidly identify personal information of athletes, prevent cheating, and improve sport management level. The completion of this system serves a promotional function for the development of college sports. Moreover, using RFID technology in college sports also significantly promotes sports as a whole.

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