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RFID-enable Real-time Multi-experiment Training Center Management System

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Abstract

This paper proposes a real-time web system based on RFID, B/S+C/S (Browser/Server + Client/Server) module and wireless communication so-called 433MHz, all of which are used to solve some crucial problems existed in multi-experiment training center such as lack of real-time data collection methodology, illegibility of task tracking and low-level training etc. The system integrates teaching management, equipment management, material management, personnel management, and other information management effectively to achieve real-time collection of various basic data so as to conduct statistics for dynamic statements, real-time queries, tracking and analysis. This novel management mode could guarantee the unified management, deployment of the experimenters and laboratory equipment, and utilization of laboratories effectively. In addition, a scientific evaluation mechanism for experimental teaching could be established by the real-time information, in order to evaluate the experimental skills, practical abilities and innovation abilities of students. Then the quality guarantee system of experimental teaching is further improved. After application in representative of training center in Guangdong University of Technology, this system has achieved good results in guiding series of engineering skills, agile training categories, large quantity of data view and so on. This system is rightly guaranteed to be a brilliant tool for high education associations for multi-experiment training.

Keywords*: RFID; Real-time; B/S+C/S; Training center;*

1. Introduction

Development of network technology accelerates the transferring and interactions of information, especially for enterprises, institutions, companies, and high education institutions. Management has brought new vigor and vitality. Microsoft has introduced a new generation of Web technology which could combine with the traditional RFID technology effectively so as to create a new Web application development platform [1]. And this combination is also capable of excellent cross-platform interoperability and the level of clarity, high maintainability and good scalability. As a result, web systems development combined with traditional tech become a popular choice.

Under this definite possibility of combination of B/S and C/S, which is applied in training system, a Web-based system combined with RFID network owns more prominent advantages. B/S is the web system which mainly focuses on the management

and user operation. C/S is a communication system which puts weight on information transfering in the lab. The methodology combined with Web and RFID is full of excellent controllability, timeliness, and openness. What is more, it highlights the real-time achievements. According to the same methodology which MES (Manufacturing Execution System) is used; the workshop present management model applies it to college engineering training courses, combined with RFID. Several programs are designed which include Web-based management system, C/S-based communication system. Those systems are a tool for information engineering training in colleges and universities in promoting the construction of multi-experiment engineering training.

College engineering training centre is mainly responsible for mechanical and manufacturing engineering training, electrical and electronic engineering training, computer assembly and network training, innovative design and production training, engineering survey training, automotive engineering training, management technology and industrial engineering training and other multiple professional teaching tasks for different professional students. It is a practical teaching base for cultivating and improving the engineering quality and skills of students comprehensively.

With the expansion of the scale of enrollment, the permeability of cross-discipline is strengthened, so that college engineering training centers are providing with more advanced equipment, more and more comprehensive training projects, wider areas, more beneficiaries and stronger model. As a result, there is an urgent need to introduce advanced management mode to improve the management efficiency with maximum extent. Although colleges and universities now have a relatively perfect management and corresponding management system, manual management and statistics are mainly dominated. According to the teaching plans of academic administrations, the centers conduct macroscopic practical and teaching arrangements (workshop as planned), and microscopic practical arrangements (equipment as planned) are carried out by the guidance teachers after the macroscopic plans are issued to the workshops according to the schemes and equipment resources. Since the information of students, the status of equipment, student scores and other information in the practice process are entered mainly by hand, real-time monitoring capacity is almost impossible. Therefore, those training centers are suffered from low level visualization and failing to give full play to advantages of the existing resources.

In order to trackle this challenges, RFID technology is the best solution for an innovation management. RFID cards of managers, teachers and students are bundled. An embedded multi-functional intelligent data terminal (IDT) has been explored and used to integrate equipment management, teaching management, materials management, human resources management and other information organically (Figure 1). And resources may be shared to the maximum extent by using RFID integration. The service efficiency of the equipment and related resources can be increased.

In the proof-of-the-concept study, high-frequency RFID technology is recommended for this system due to its affordable cost and practically acceptable reading capability. Especially, high-frequency RFID technology is used universally in all the high education institutions in Guangzhou city.

This paper is mainly aimed to enhance the efficiency of the practical resources of engineering training centers, improve the flexibility about studying of trainees and take the state teaching pilot demonstration base – the engineering training center of Guangdong University of Technology in Guangzhou High Education Mega Center (GHEMC) as an application background. RFID technology is used as identity tags of teachers and students.

The IDT with independent intellectual property right is used as an information exchange platform for workshops. IDTs are also used to establish an improved three-layer architecture combined with B/S infrastructure for the overall planning of the system structure. Then the templates such as the teaching management, equipment management, materials management, monitoring management, performance management, system management are developed. Training plans for different training engineering projects can be scheduled, appointed and implemented to achieve the off-site real-time monitoring, visualization and paperless management.

Figure 1. IDT and deployment

The system interacts and integrates with information of the teaching management system, the academic administration and the equipment management system. It also bundles trainees and teachers with the equipment separately, and issues the teaching plans and production process and other experimental guidance information directly to the IDTs related with equipments. Thus teachers and students through IDTs can simultaneously understand the practice plans and process status of all working procedures in the entire process. And real-time practice, teaching outlines, practice guidance and other help documents can also be got from them. Teachers can also submit real-time equipment condition, practice results and feedback of students through IDTs, so as to conduct real-time monitoring and visualization management of the entire practice process. All of these achievements are based on RFID technology which is justified to be excellent scenario.

2. RFID technology

RFID (Radio Frequency Identification) is an advanced automatic identification technology [2-3]. Compared with traditional bar code and magnetic cards and IC cards, RFID is excellent in non-contact identification, fast reading speed, immunity of environmental impact, long service life, and easy-to-use. Futher more, RFID also contains anti-collision function, which can simultaneously handle more than one card [4]. This system used RFID is to achieve application of automated information collection, which is to ensure that items can be identified. This typical system consists of RFID tags, readers, antenna, and base station and computers (Figure 2). The required information will be encoded into the electronic label, using electromagnetic induction or microwave non-contact two-way communication. And it achieves identification of targets through the exchange of data, which would effectively guarantee data reliability and accuracy. At present, with the maturation of RFID technology in the asset

management applications, costs related products continue to decline, and its usage becomes more and more widely [5-11].

Figure 2. Principle of RFID

RFID is very qualified in multi-experiment training center because of its environmental adaptability, the ability of read and write, and its excellent advantages: (1) small, non-contact, reusable; (2) security, anti-cloning; (3) anti-pollution, flexible identification; (4) rewritten; (5) multi-tag identification at the same time. Using the highlighted features of RFID, which is the best available methodology improved the present management in the workshop, manufacturing industry have used this technology to tracking production and processes. Notwithstanding RFID has been used in large quantity of fields, multi-experiment training center has not been awaked as some intricate reasons such as magnetic interference, cost, oil pollution, etc.

The management of equipment can not be separated from the application of information technology. Equipment management process focuses on how to obtain reliable and valid data and information (especially the equipment operating status information) which is particularly important in the system based on the adoption of RFID technology. The condition information of operation machinery could be monitored and real-time accessed via RFID tech. Further more, information about users on the equipment could also be accessed so as to provide sufficient data to support decision-making when the dynamic curriculum frequently changes.

3. Overview of RFID-enable real-time multi-experiment training center management system

This system contains two main parts: hardware and software. Hardware is a platform allocated in the training area for information collection and displaying. It contains RFID readers and communication components. And a network for communication is also belongs to hardware. The other is software, which is a cooperation platform with hardware.

3.1. Hardware

Hardware of RFID-enable Rea-time Multi-experiment Training Center Management System (RRMTCMS), taking the network as an instance (figure 3), is a platform which

contains IDT (Intelligent Data Terminal), BS (Base Station), cable, PCI cards, WS (Work Station) and server. There are three types of network could be used according to the workshop environment and wiring way, including RS485, TCP/IP and 433MHZ wireless communication [12]. And two types of IDT have been developed, one is fixed one and the other is hand-held one, however they have the same function but the hand-held type is much more convenient especially for the warehouse holders and quality checkers. The communication speed could reach 2400bps to 115200bps which depends on the network you choose. The following figure shows a classic network which is set up in RRMTCMS, where are deployed IDTs, WS and servers. After testing with the connection of each component such as computer and cable, cable and BS, PCI-1612 card of four or eight COMs is used for each WS depended on the channel deployed in the workshop.

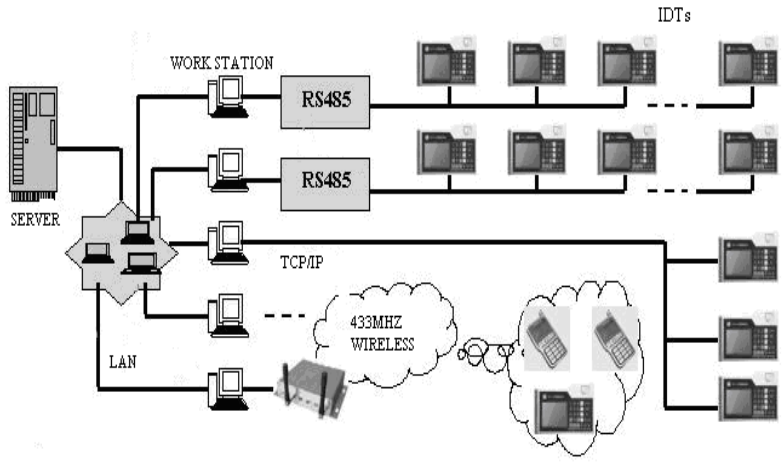


Figure 3. Hardware and network design

3.1.1. Intelligent Data Terminal (IDT)

From figure 3, the mainly function of IDT is to input/output data and display some basic information which is deployed in the workshops. There are seven main components of IDT, which are showed in figure 4.

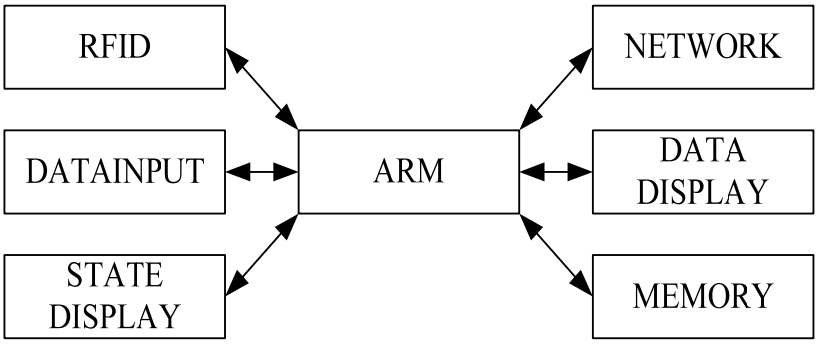


Figure 4. IDT components

The IDT based on RFID is controlled by the communication procedure up located in WS connected with BS via cable. Data communication protocol is definition followed this rule:

Start (1) address (4) CID (1) STEP (1) INFOLEN (4) XXXX (information contents) CHECK (4) End (1): start: beginning of character string, (1)-represents the length which means 1 Byte; address: the address of IDT with the length of 4 Byte; CID: Current window identity uses one Byte to represent; STEP: the next CID of window when there are some commands took place; INFOLEN: using 4 Byte to record the context length of information communication between IDTs and BS; CHECK: sum of all characters of the string as ASCII then 'and' the sum and FFFF; end: flag of the end.

For example: CID=0, STEP=0 represents an identity code of one window. The string "#1'0105'#$A#$A'0000019A'#2" could be interpreted as: #1: data head, #2: data tail, '0105': IDT address, '#$A#$A': compiled by the object-oriented language, stand for CID=0, STEP=0, '0000': information contents, '019A': check code. IDT sends such string to BS, and then WS receives the string and analyzes them. If the window code is CID=3, STEP=0, the communication procedure converts CID and STEP into '#$D#$A', then reads and judges the information. The principle of IDT how to process production data was shown in figure 5:

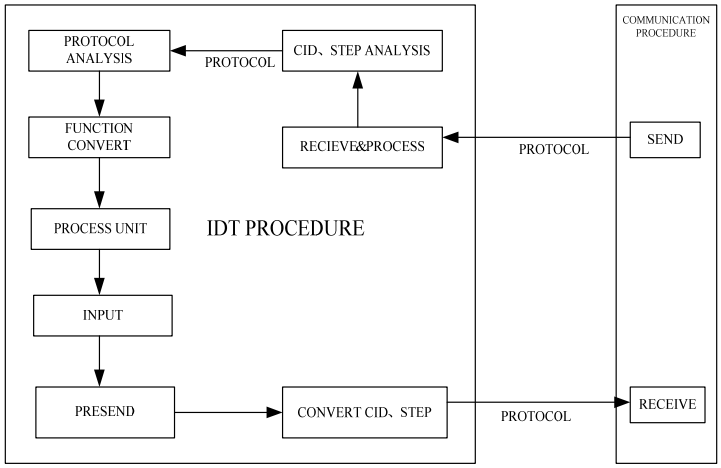


Figure 5. Principal of IDT

Two types of IDT have been produced. As mentioned above, IDT had integrated primary components which RFID is one of the most vital one that could read tags and display information which is auxiliary for the training. Students or trainers usually operate machines, which IDTs are located on or near as convenient as possible. And another reason is the convenience of fetching power sources from machines, as a result, each machine is fixed a IDT for display all the instructions and technologies. After some trails, this deploy methodology is considered to be best one as it is costumed to operators and ambidextrous to the view of technologies while working.

Notwithstanding there are mainly two types of frequency used for RRMTCMS, one was 125KHz as low frequency, and the other was 13.56MHz as high frequency which are used most as the reason of the function range and anti-interference [13-14]. Compared those two kinds of frequency, identification speed of high frequency is less one second than that of low one. Despite the high frequency is the most suitable one for RRMTCMS, as to be a universal and ambidextrous terminal for all manufacturing fields, two frequencies are available after

configuration. That means you could choose one of them as you want. Some technical indicators of IDT are shown in the following texts:

IDT technical indicators:

Power Supply :(DC3.3~7.5) ±10%;

Screen: 320*240;

Keyboard: 32;

Network Interface: TCP/IP, RS422, 433MHz;

Communication Distance :> 500m;

Working Frequency: 430~434MHz;

Power :> 10mW;

BPS: 1200/2400/4800/9600/19200;

Temperature:-10~55°C

Humidity: 10~90%

3.1.2. Base Station (BS)

BS (Base Station), a bridge between WS and IDTs is the other hardware for communication between IDTs and computers, which is the mainly distributing and transferring part in this system which contains five main parts: net control, data process, memory, MCU, send/receive unit. The following figure 6 shows the components of BS and product which has been produced.

IDTs do communicate with BS through a wireless networks. Each IDT is controlled by WS located in the workshop office centrally, which connects with BS by PCI-1612 card and masked-cable. The BS occupies one frequency with the aim of interference with 50 KHz as bandwidth.

All the hardware is proposed except the networks which is primary in the information transferring function. The following passages demonstrate wireless network and anti-collision strategy in this network.

Some technical indicators of BS are shown as following:

Power Supply: DC7.5;

Channel available: 8;

Connection: cable, DB-9;

Network: 433MHz;

Communication Distance :> 500m;

Working Frequency: 430~434MHz;

Power :> 10mW;

BPS Available: 1200/2400/4800/9600/19200;

Temperature: -10~55C

Humidity: 10~90%

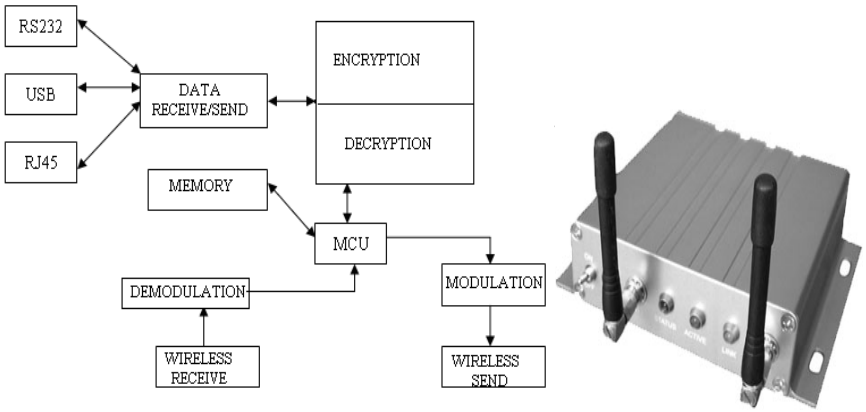


Figure 6. BS and its Components

3.1.3 433MHz Wireless network

433MHZ frequency belongs to international ISM frequency channel and suits for developing near-range wireless communication products. The TDMA technology of RF433MHZ communication in workshop is developed on the RF CC1020 hardware platform. In implementation of RRMTCMS, due to large quantities of acquisitions, cost, speed, beneficial result, and energy-saving should be considered adequately. The characteristics of the 433MHZ wireless communication form based on RF CC1020 are as follows:

(1) Micro-power transmission: transmission power is 10mW; the increasing output power amplifying could reach 100mW.

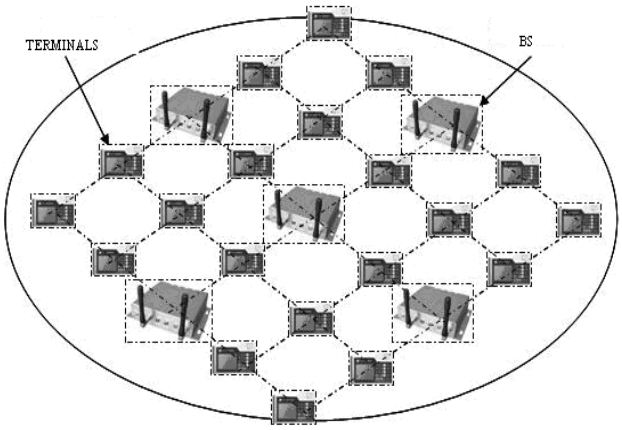
(2) With strong anti-jam capability and low BER.

(3) It uses FSK modulation, high efficiency and forward error correction coding technology to improve the ability for anti- collision and random disturbance.

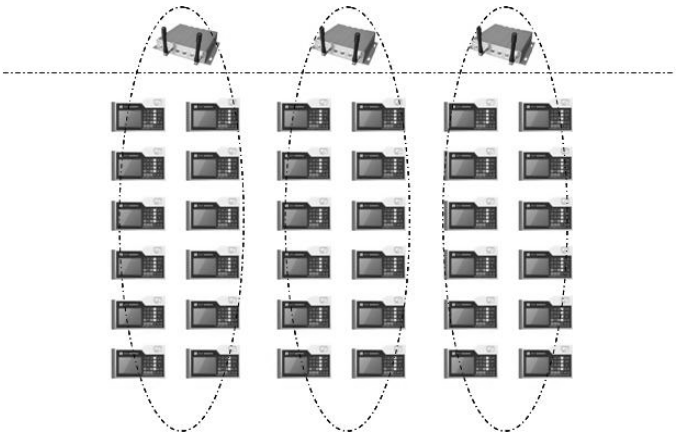
(4) Farther transmission distance: under apparent distance state, the reliable transmission distance is up to 500m.

According to the classification of IEEE802.15.4 protocol, RF 433MHZ network belongs to LR-WPAN (Low-rate Wireless Personal Networks). An LR-WPAN network is a simple and low-cost communication network that allows the realization of wireless networking on the premise of limited power dissipation. There are two structures for the 433MHz wireless communication network, one is honeycomb form, and another is bus-lan form, both of which are shown in the following figure 7.

The traditional synchronization method in this network is turn-inquiry system, which means each terminal in local network have a unique physical address and BS acquires data from an IDT of a certain physical address at fixed intervals. If one IDT want to submit to the BS, it would be allowed to transmit; otherwise, the BS would be informed to inquire next one. The turn-inquiry system is relatively easier to implement, as there are some inevitable disadvantages in utilization rate of channel. If there are N IDTs in a local network, the time interval for BS to turn-inquire each IDT is S ms, the total time for the base station to turn-inquire all IDTs in the LAN in the requirements is at least N×S ms and each IDT occupied 1/N channel.



a)Honeycomb Network



b)Bus-lan Network

Figure 7. Two types of communication network

However, in the RF 433MHz wireless networks, all terminals in the LAN use the same physical frequency channel. If they communicate with BS at the same time, collisions would be occurred. In order to avoid that, synchronization mechanisms must be used.

3.1.4Anti-collision strategy

Both of BS and IDT could avoid frequency collision in data transmission, because the frequency could be selected from a frequency band range of over 420 MHZ to 440MHZ to avoid collision. Within the above frequency range there would be tens of frequency points for selection if using 500 KHZ as frequency bandwidth. As the reason of most wireless transceiver chips have no collision detection function, if there are two or more RF (Radio Frequency) modules in one channel sending data at the same time, data collision and loss would be occurred. In the interesting of solving this problem, a special communication protocol is designed to avoid data collisions.

In above-mentioned networking mode, there is only one BS in a local network, so there is no data collision when BS sends data to the terminals. The main task is against the data

collision between IDTs when they send data to the BS. In order to solve the problem, a communication mechanism is customized, as shown in Figure 8. The BS sends broadcast to all IDTs; when one IDT needs submit data after have received information. It should register to the BS first. After received registration information, BS would inquire all IDTs one by one according to the addresses. In the process, data collisions may occur after the broadcast sent by BS, because many terminals may register to a BS at the same time. So the solution is avoiding sending registration immediately to the BS, but entering a contention registration to the BS N time-sequences later with a random number which is proposed by the system as time delaying parameter.

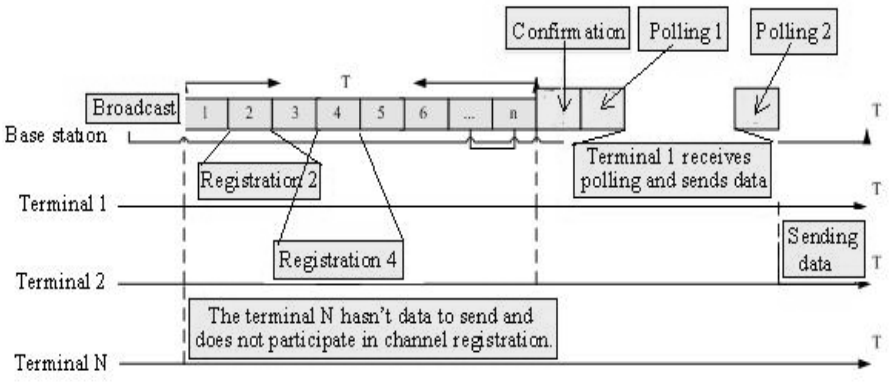


Figure 8. Diagram of time sequence between BS and IDTs

This system uses such network and strategy which has been implemented in many large-scale manufacturing enterprises in Guangdong Province and the engineering training center of Guangdong University of Technology in China. The wireless communication scheme proposed in this paper featured a high reliability, good stability, low cost and easy realization.

3.2. Software

The system mainly serves schools, enterprises, shop staff, equipment managers, and students. It also provides some features of serves such as the management of teaching process, information, engineering training for colleges and universities [15-16].

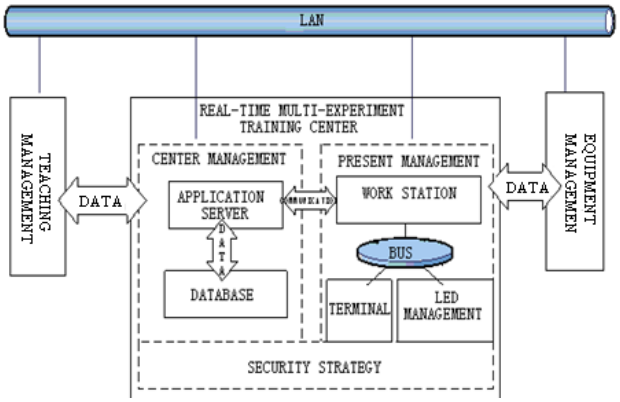


Figure 9. System framework

This system mainly includes two parts: center management and present management which are shown in figure 9 based on the campus LAN.

3.2.1. Center management sub-system

Center management sub-system is a real-time Web management system, mainly realized user-oriented management and learning function such as query and scanning. And center management system provides engineer training processes management via B/S module. Through center management sub-system, users are able to monitor and manage the implementation of projects carried out at the scene so as to guide the process of training. But it could also conduct real-time access to learning and operational guidance.

Centre management sub-system includes an application server and database server. B/S network structure is used to form the presentation layer, business layer and data storage layer of thin clients based on WEB browser. Different types of practice resources are uniformly scheduled and managed so as to assist school leaders, academic administrators, teachers and students to conduct the overall management and learning of day-to-day teaching tasks. The frame construction of the centre management system is shown in Figure 10.

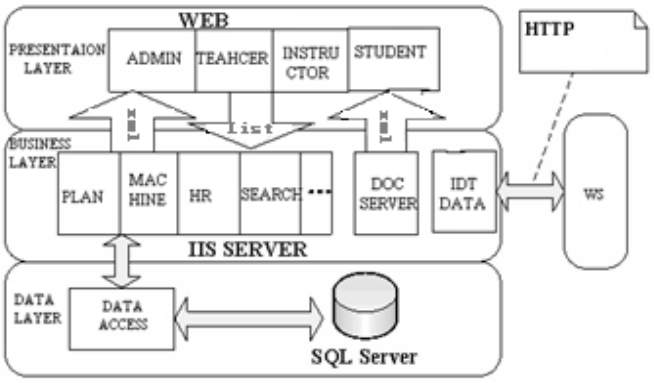


Figure 10. Centre management sub-system structure

The main tasks of the centre management sub-system are providing users with a convenient , friendly visualization platform and focusing on management of teaching, equipment, assets , personnel, and offering teaching management, authority management, system monitoring, statistical inquiry, system management, assets management, materials management, teaching inquiry, user information modification and other functional modules.

3.2.2 Present management sub-system

Present management sub-system uses C/S structure which is divided into a workshop and operation of Terminal System. The terminal system is a distribution of hardware that main major is to display and collect real-time training data with 433MHz wireless communication protocol [12].

The present management sub-system is achieved by C/S structure and divided into two levels: workshop workstation and operating terminal system. The workshop workstation can communicate with the workshop data inquiry terminals through site workshop bus or TCP/IP or 433MHz wireless or other communication mode mentioned above. The structure of the site management system is shown in Figure 11.

3.3 Workstation

Workstation as a server for the terminals provides data services to upload and transfer information to every student who is going to have this training.

Terminal operation system is involved in training students in the entire process, whose main function is to identify student via RFID cards, track attendance, search information, and view operation guidance [17]. At the same time teachers are provided for the services of attendance querying, information querying, performance evaluation, equipment management and some other functions.

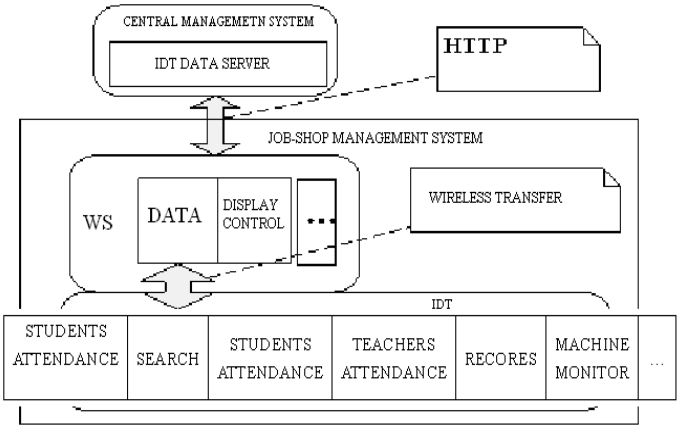


Figure 11. Structure of the present management sub-system

The workshop workstation is placed in each workshop and is responsible for the information collection and management of the corresponding intelligent management terminals in each workshop. It provides workshop information data to the management service program and is a bridge of communication between the workshop site and the management. First of all, the operation authorities of all users are input and defined. The data collected for various needs and the production processes applicable to the characteristics of each station are defined. In accordance with the requests of various needs, all display information and course information as well as practical tasks is issued by IDTs. At the same time workshop panels are controlled, information display panels is customized; the data collected by the IDTs are submitted to the interface of the center management subsystem. The workshop managers can adjust the trainees and plans appropriately.

IDTs are installed and bundled on the practice site with specific equipment, that means the IDT mentioned correspondingly communicate or connected with the specific equipment. They collect the dynamic operating information of the corresponding equipment or working stations directly or indirectly, such as operating status of the equipment, operating time, the maintenance time and results of the learners who practice on the equipment. They also provide the site practice process with attendance, data inquiry, operating guidance. At the same time, they provide an exchange platform for attendance, inquiry, results evaluation and equipment information management. All data collected by the IDTs are timely sent to the workshop workstations. Functions of

IDT are as follows: (1) acquisition of practice program, (2) acquisition and display of equipment information, (3) inquiry of practice processes, (4) report of equipment status, (5) evaluation of teacher results.

The communication management module is separately connected to more than eight IDTs .In the circumstance of wireless connectivity; one or more wireless base stations are set up in order to prevent data signals from excessive collisions. The system real practical running window is shown in the following figure 12.

Figure 12. System running windows

4. Optimization

4.1 Modular optimization

As data interaction relatively frequent between the functional modules and real-time Web system, all the functional modules above are required to be optimized to meet the needs of users and management requirements.

In order to increase transmission efficiency of the data, some simple data are processed and calculated by the client in the system by means of XML technology, so an independent service program forming into a virtual four-layer B/S organizational structure is designed (figure 13). The necessity for expansion of the three-layer B/S is also explained by the development environment of visual studio 2005. The independence service program increased can reduce data transmission of client and server and improve the utilization rate of resources and implementation efficiency.

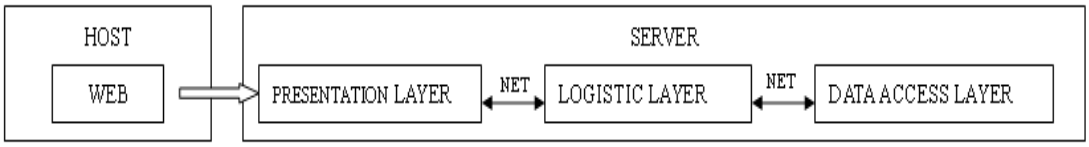


Figure 13. Frame organization method

In addition, the adjustment scheme of the system also includes the entity data, data types, local and global variables and so on. First of all, the data cache mechanism is used for the page data. And .NET owns strong data processing ability. When a user sends the page request, the system first checks whether there is the object inside the cache, and then returns to the client.Afer the check, the system will inquire the database and then return the inquired results via the web. Data exchanges between all pages and database or the information of pages obtained could be viewed by session. Once again, excessive data going back and forth between the database and Web pages are well designed, the client resources are used to verify the input data, and the press of database is reduced. The data types are appropriately adjusted, and the new requirements can be met as long as the values of the parameters are modified when the program is modified to establish a re-load mechanism. The global variables and local variables are appropriately arranged because the global variables play a role in the survival period of the whole program, it is necessary to verify them because of their impact. Local variables should act locally in the survival period, so there is no impact on other data. The resources are timely released, that is, the resources occupied must be released after completion, and if too many objects have not been released, the working space is increased and the system resources are reduced. The resources of the objects are released by the function named close (). At last , in the lower layer, terminals which collect and upload data by wireless are operated in the database as far as possible, so as to prevent the duplication of data flow to the database through Web system.

In this system, the application layer on a separate independent is on the server. As long as the client-side interfaces and services could deal with some simple calculations so as to release the client, what is more important is to reduce the data processing pressure of server-side.

There are some advantages by applying the above methodology:

- ✧sharing of the server data processing pressure, the simple logic operations and calculation are completed on the client so as to reduce server press;
- ✧reducing the flow and stream exchanges of data between client and server, saving bandwidth constraints during data flow requirements;
- ✧acilitating the realization of modular interface, which could also enhance the independence of the function modules to achieve a good design goal under bandwidth limitations ;
- ✧reducing refresh frequency to facilitate the realization of "WYSIWYG" design philosophy;
- ✧preventing a variety of database connections by a unified database connection interface standardization;
- ✧reducing unnecessary data transmission, and improving resource utilization and process efficiency, as the aim of increasing system stability;
- ✧reducing maintenance time and cost;

As the interaction of data and Web system requirements for real-time requirements, it is necessary to optimize the function modules, so as to achieve excellent performances. Module optimizations are mainly illustrated in the following texts: (1) using data package and interface design features to achieve data coherence ; (2) using sub-level methodology to design the function of sub-module, between each levels with AOE Network modules required for the completion; (3) whole system is divided by functional modules into several levels of abstraction, so each object is distinct; (4) forecasting data integrity and consistency; (5) In order to maintain data flow

consistency, the entire system data is monitored by the management of whole approach to prevent, produce and read "dirty data".

4.2 System adjustment

System adjustment programs include data physical adjustments, data type adjustment, local and global variables adjustment, etc.

Firstly, page of data uses data caching mechanism, which is .Net's own strong data processing. When one user requests a page, the system first checks the cache, if there is existed, and then returns to the client, if not then queries the database. Last query results are returned to the customer through the web page. All pages and data exchanges between databases are available through session.

Secondly, to avoid too much data intercommunication between database and Web page, appropriate server control is introduced to reduce the database pressure.

Thirdly, the modification process as long as the amendments to the value of the parameter is to meet the new requirements. Then establishment of heavy-duty mechanism is rebuilt.

Fourthly, global variables and local variables are made appropriate arrangements. As global variables for the survival of the whole process work period, it is necessary to be verified, because it affects the whole process of data. Local variables should accomplish the partial role in the survival period so as not to have an impact on other data.

Fifthly, it is primary to release resources timely. When the code is not released after the completion of sharing of resources, too much created objects would occupy resources, in the results of increasing of threads and the reduction of system resources. Thus the overall system performance will be depredated. Close () method is used to complete the release.

Finally, low-level data, especially collected by wireless terminal is completed to prevent the adoption of Web system to write back to the database once again to repeat the operation data streams.

4.3 Code optimization

4.3.1 Optimization Methodologies

Test results show that the code quality directly affects the whole performance and maintenance of a system. Code reusing and reconstruction not only could improve the quality of code, but also could improve the maintainability of the procedure. So it is necessary to optimize the code. In this system, optimizations follow the texts:

(1) Code testing: to complete this one, confirmation process functions in all cases should be followed output function and design object method. After that, this code would have a high reliability;

(2) Code reusing: some methods are used for code design. As long as program could call functions, this system uses common.cs and CSS documents, such as public static void LogEMOperation () {~}, to complete the logging operation;

(3) Database connection: the definition of a unified database of links is proposed to operate string public class ConnStr (public static string ConnString = onfigurationManager.ConnectionStrings ["ConnStringName"]. ConnectionString;);

(4) exception monitoring: database operation that may arise in the operation of a number of anomalies, so we used the following code to monitor abnormal: try (~) catch (Exception) (~);

(5) e-forms package: all the documents in electronic form are abstracted into a category. Then object operation is achieved to complete the form processing, which could be inherited, such as derivatives to achieve the same treatment.

4.3.2 Improvement

This system has been implicated in the Engineering Training Center in Guang Dong University of Technology since Sep.2007. After one year testing and improving, great benefits have been achieved via accelerate information transmission and real-time tasks assignment using 433MHz wireless communication and RFID which is mainly used for the identification of users and attendances. Some indicators are informed in the following table 1.

At present, Guangdong University has developed into a set of turner, fitter, CNC, casting, and assembling etc. It also owns more than 10 workshops, which has the training capacity of 500 persons / day in the large-scale comprehensive training center. The information intercommunication between teachers and students, teaching management and the teaching departments, engineering training center and management department is greatly increasing for exchanging and sharing sources. Engineering Training Center through this RRMTCMS enables to deal with a variety of data processing and analyze the increasing workload and complexity.The traditional extensive manual management methods can not meet the teaching issues to establish a highly efficient and flexible management information system. As a result, RRMTCMS obtains the achievement of dynamic and self-configuration teaching, freely information exchanging, practice plans and issues real-time reporting, online scheduling, timely practice and teaching evaluation. Moreover, equipment, materials and other functions are also maintained in this system so as to achieve agile response to every emergency.

At present, the engineering training practice management system owns the following characteristics:

1) Management System and more students to practice based on the curriculum management style, stay in the upper deck, not taking into account the specific plant and equipment management.

2) Management system with B / S mode or C / S mode to achieve;

3) Management System integration is not high, can only be carried out with the teaching-related practices, achievements, simple fragmented management courses.

Table 1. Hardware achievement

ITEMS	DATA
Furthest Range	500m
Number of Terminals	60sets
Picture Download Time	<5s
BER	<0.001
Resend Rate	<0.01
Packet Loss Rate	<0.0001
Keyboard Average Response Time	<1s

As the system based on B/S+C/S, there is not only campus networks but also Internet could logon this system which means the resources sharing is more higher than before as operated by hand only in the past. Some good results have been achieved from the tables.

This paper introduces a real-time experimental training system integrated the use of C/S+B/S as system structure, which is proofed to be a good method which is able to meet the requirements of real-time teaching and tracking.

Table 2. Improvement

Items	**Comparisons**	
	Before	**Now**
Information Respond	Slow (cross Depart.)	Real-time
Task correction	90%	99%
Paper saving	100%	0%(Paperless)
Teacher's work	100%	50%
Resources sharing	Low	High
Data input	100%	10%
Visualization	20%	>95%

With the traditional combination of C/S and B/S, this system has achieved such following obvious advantages after practice in Guangdong University of Technology Traning Center:

1) Real-time processing

Using of the above data processing system, WEB page could entered and modified data in real-time spread of system C/S structure with RFID terminals. So this system can reach a high real-time requirement to meet the training process of the timeliness of information transferring issues;

2) Good system stability

Because of the advantages of C/S+B/S, the system uses this architecture best met the functional and performance requirements. After the relevant data processed in the two modes, this system achieves a consistency of data by testing in high-intensity.

3) Optimization under limited resources

Based on B/S greatly affected by network bandwidth, we use such combination of B/S and C/S to reduce the bandwidth limitations of the data traffic. In accordance with the requirements of actual system, we optimize data packet and made use of relevant WEB server programming techniques to alleviate the pressure.

4) Various forms of data views

The system has various forms of data presentation. One is shown on RFID terminal screen with the experiment content, equipment information etc. The other is LED displaying with workshop teaching tasks, student information. Third, workstation with teaching information monitoring is viewed in the computer. The last one is the adoption of RFID terminal displayed in monitor via cable.

5. Key technologies

Some key technologies are illustrated in the following passages included all the functions of real-time multi-experiment training center.

(1) Bulk data processing techniques

BS (Base station) based on 433MHz wireless communication is a bridge between data collecting and displaying terminals. And WS (Work Station) uses multi-serial card to connect to the corresponding BS. Terminals are set up through channel number and address to identify its distinction. The same line has same channel frequency, so as to distinguish different lines. The addresses are different from a distinction between different terminals. BSs communicate by differ frequencies with the terminals. Communication program which is mainly to control communication mechanisms used multi-thread synchronization techniques and DLL to solve bulk data upload and download issues which are frequently occurred.

(2) BLOB (Binary Large Object) data-processing technology

BLOB data is a binary large object data, such as pictures, documents, and multimedia data. In the C/S structure, the graphics is saved in a binary file, so the using should be in the form of packet transmission. However in B/S structure, it is general to use relative path to access its file name, but in this system it uses byte [] binData method to get those files, and myFile2.PostedFile.InputStream.Read to process. The using of binary data stream technology and realization of BLOB data in the database access is a realization of two structural data compatibility mode.

(3) C/S+B/S real-time data processing technology

The system uses C/S+B/S combination of design method. In both modes, it must adopt a certain degree of effective transfer mechanism in order to achieve real-time data transmission. Accordingly, the system mainly carries out following data transmissions. In C/S model, using real-time data communication program for all bus terminals is a good way to achieve enquiries. When the terminals are in operation and communication controlled for access data from the database, the obtained data is sent to the terminal. Communication program uses 1/N seconds repeatedly polling interval (N for the terminal number). In the other hand, B/S model uses JavaScript to detect database. When database updated, data accessing is sent to Web page.

(4) Data consistency Tec

As the system database preserves text data, binary data streams, multimedia data, XML data, and other data, which must be processed under C/S and B/S module. It is important to maintain the consistency. We adopt the following techniques to achieve the goal:

- Services Technology: Service is used to access and modify the procedures of various kinds of data units, which are panels during the data-processing. It should be either completed or not, known as "atomic" Therefore it is also to prevent “read repeat”, “write repeat”, and “read dirty data”.
- Concurrency control techniques: it is a realization of affairs orderly. In order to achieve this implementation, each data item sets up a mutually exclusive lock, which is mutually exclusive and marked as resource.

6. Conclusion

This paper introduces an RFID-enable real-time multi-experiment training center. RFID technology is used timely and accurately to access real-time information, which could track and retrospect the staff, materials, equipment status, and the implementation of teaching plans, detect the bottlenecks in practice and realize the real-time scheduling in practice. The workshop processed practice information is timely feeded back to the top management system, which not only provides scientific decision-making for the school with support, but more importantly provides the resources-sharing of more than 10 colleges and universities in GHEMC. This system plays very greatly significance on realizing the brilliant management of the experimental center, enhances the workshop tracking capability, improves the utilization rate of laboratory equipment, reduces training costs, promotes the comprehensive applications of scientific research results in the experimental teaching field, and builds the engineering training center into a state scientific research, teaching and experimental demonstration. With the combination of scientific research and teaching experiment, the relevant research results could also be applied and promoted in other colleges and universities. Other engineering training aspects are promoted with very broad application prospects.

Real-time multi-experimental training center management system is a good tool to help teachers and students to get dynamic information and operation guidance via RFID terminals. And this system is easy logon as long as you could use the IE where enter the URL to get the crucial information in advance. The other is through the RFID card registry. Both of methods could monitor the entire system data, management, setting parameters etc. Students could view the information operations, usage of varied and flexible manner of data information collection and integration of examinations and self-established studying.

However there are some limitations and improvements for this system. First, interface intercommunicated with other systems should be set up in order to accelerate information delivering speed. Then, dynamic training plan scheduling is one of the most vital problems which should be solved urgently as all of the works should be input by hands. Some of the machinery distribution can be automated by system itself, but most of tasks achieved by hands.

Overall, this system proposed in this paper provides a great implementation of integration of RFID, wireless communication, Web tech and C/S module. Great progress is achieved according to the practice. This paper would like to bring some brainstorms to this research fields.

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