The Design and Implantation of A Vehicle Access Control System Based on Double Cards Recognition

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***Abstract*—A solution of vehicle access control system based on double cards (vehicle RFID card and staff RFID card) recognition is proposed. The Barrier gate opens when the combination of vehicle RFID card and staff RFID card follow the passing rule. The vehicle access control system is developed. The network architecture and the hardware of the control system are described. The data structure and code stored in the RFID cards about special car and private car are introduced. Double cards identifying process is demonstrated. This system meets some special demands of vehicle access control.**

***Index Terms*—double cards recognition, vehicle access control system, RFID cards**

I. Introduction

Nowadays, manual operation has been replaced gradually by remote card reading vehicle access control systems. The mainstream method of information acquisition for the system is to employ the RFID cards [1], because they are small, secure, reliable, effective, flexible and convenient. The vehicle access control system employs two kinds of RFID cards: vehicle RFID card and staff RFID card. A vehicle RFID card is embedded in every special car which is owned by government agencies or other organizations rather than an individual or a family. An employee who is qualified to use the special car is provided with a privilege staff RFID card. Only if a vehicle RFID card and a privilege staff RFID card are both provided, the special car is allowed to pass the gateway.

II. The Topology of the Vehicle Access Control System

The vehicle access control system is an embedded system based on double access cards recognition. The whole system consists of server, communication gateway devices, computers, and card reading control subsystems [2]. The topology of the vehicle access control system is shown in Fig. 1.

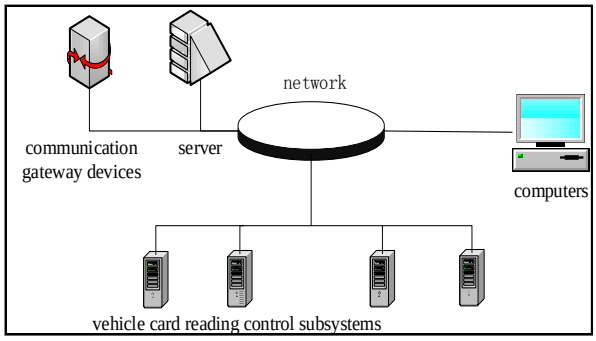

Figure 1. The topology of the vehicle access control system

The vehicle card reading control subsystem is linked to the server and computer via Ethernet. The operating system of the vehicle card reading control subsystem is μC/OS-II, which is a real time embedded system.

III. The Design of Hardware

A. Vehicle Card Reading Control Subsystem

Vehicle card reading control subsystem consists of vehicle card reading controller, RFID reader, and vehicle access controller. The vehicle access controller is connected with vehicle detector, access screen, and automatic barrier [3]. The hardware structure of vehicle card reading control subsystem is shown in Fig. 2.

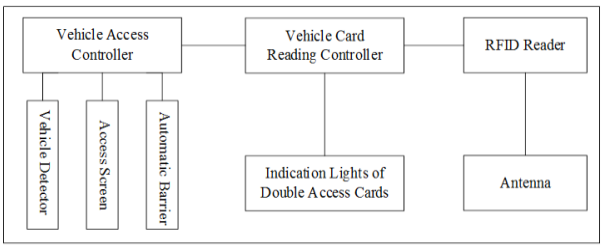

Figure 2. The hardware structure of vehicle card reading control subsystem

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Vehicle card reading controller is the core of the vehicle card reading control subsystem. The connection between the RFID reader and the vehicle card reading controller is based on TCP/IP protocol. Once the RFID reader gets the information stored in a registered RFID card, the information will be sent to vehicle card reading controller via Ethernet. The vehicle card reading controller examines the validity of the card, and it decides to open the gate or not. The computer is used to inquiry the record of the vehicles that get through the gate. The server receives the record from the local database.

B. *The Hardware Structure of the Vehicle Card Reading Controller Subsystem*

The vehicle card reading controller subsystem consists of a micro-controller, power module, clock chip, internet communication module, serial communication module, flash chip [4]. The hardware structure of card reading controller is shown in Fig. 3.

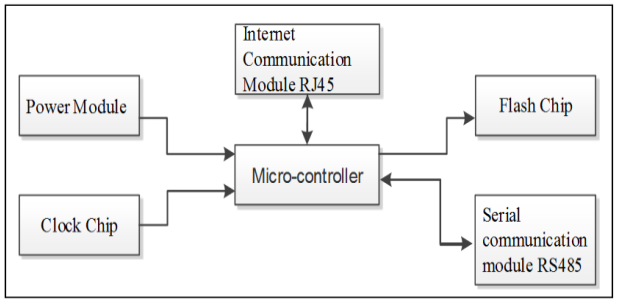

Figure 3. The hardware structure of card reading controller

IV. The Design of Software

A. *The Format of the Cards Information Stored in Database*

The software is designed for recording and managing the vehicle information. When a RFID reader the signal of the vehicle RFID cards and the staff RFID cards, information which stored in those RFID cards is sent to the computer to be compared with the record in the database. Furthermore, the software is able to synchronize the data with database [5], [6].

The cards in the system can be divided into staff RFID cards and vehicle RFID cards. The card number which stored in the card is BCD code. Each of the 8 digits ranges from 0 to 9. For example, in the card number 0x11111111, the first digit is class code which determine the type of the card holder, either vehicle or different kinds of people. The second digit to the sixth digit is provided by organization. The seventh digit and eighth digit is zero. The class code in this system ranges from 1 to 6. 1 to 4 represents the class code of the staff RFID card. The class code 5 is preserved for backup. The class code 6 represents vehicle RFID card. If there is a record in the database which the card number is 0x11111111, an employee with a staff RFID card number 0x11111111 is allowed to pass, drive a private car. The special car is allowed to pass only when the vehicle RFID card matches with the staff RFID card. For example, a special car with a vehicle RFID card number 0x61111100 matches with a staff RFID card number 0x11111111 to produce a combination card number 0x61111111. If there is a record of combination card number 0x61111111 in the database, the special car is allowed to pass. The data structure of staff RFID cards is shown in Table I.

TABLE I. Data Structure of Staff RFID Cards

Byte	1		2		3		4	
BCD code	1	2	3	4	5	6	7	8
Code Rules	card Number (number of digits is 8)							
	Classes	Code of Organization			Staff Code			
Code Example	1	0	1	2	0	0	0	1
Class Definition	1	Permanent Employee						
	2	Short-term Employee						
	3	Non-staff people						
	4	Cooperation Staff						

The vehicle RFID cards are fixed in the special cars, and the vehicle RFID cards are not allowed to carry by anyone. An authorized employee with a privileged staff RFID card and a vehicle RFID card is allowed to pass the gateway with the special car. The data structure of vehicle RFID cards is shown in Table II.

TABLE II. Data Structure of Vehicle RFID Cards

Byte	1		2		3		4	
BCD code	1	2	3	4	5	6	7	8
Code Rules	classes	Code of Organization			Vehicle Code		Combination Code	
Code Example	6	0	1	2	0	1	0	0
	6	0	1	2	0	1	0	0
	6	0	1	2	0	1	1	

The format of the data about the cards can be described as follows:

When it gets the data from the RFID reader conveyed via the network, the software begins to operate. All the

data in the cards are 4 bytes, which equal to the binary digits of 8 BCD code.

The first BCD code is a class code which is about permanent employee, short-term employee, non-employee, associate staff, and vehicle.

The second, third, and fourth BCD codes together are organization code, which defines its organization.

The fifth, sixth, seventh, and eighth BCD codes are staff code.

B. Double Cards Identifying Process

The RFID reader begins to work if there is any card within the receiving range. If it is a private car that's passing the gateway, the RFID reader is able to read the staff RFID card in the vehicle. If it is a special car which is the organization's property, the data of a staff RFID card and a vehicle RFID card should be received at the same time. The vehicle RFID reading controller gets the information of the cards in a data request way. Since the data obtained from the RFID reader may be loads of repeating information which cannot be used directly for the double access cards recognition progress, the data should be shifted to make sure that there is no duplicate information of the staff RFID cards and vehicle RFID cards. The double cards identifying process is shown in Fig. 4.

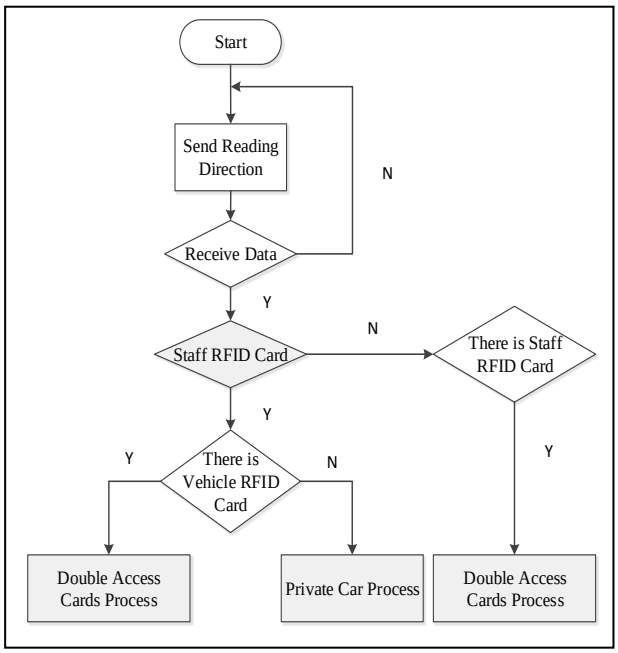

Figure 4. Data recording process

The double access cards recognition process starts after the buffer is cleared. The whole process is based on the information of the staff RFID cards. The software makes a judgment one by one about whether the cards are staff RFID cards. If the RFID card is not a staff RFID card, the RFID reader searches for a staff RFID card. When the RFID reader gets a staff RFID card, the program enters the double access cards process which is about matching the information of the two kinds of RFID cards with the record in the database. If the card is a staff RFID card, the next step is to detect whether there is a vehicle RFID card. If there is a vehicle RFID card, the program enters the double access cards process. If there is no vehicle RFID card detected, the program enters the private car process which is about matching the information of the staff RFID card with the record in the database.

C. Information of Cards and the Date of Local Database Record

When the vehicle with a vehicle RFID card passes, the system will store the information of the vehicle RFID card. The number of records in local database should be more than 3000 as a backup.

TABLE III. THE FORMAT OF DATA RECORDING OF VEHICLE ACCESS

Number	Code Name	Byte Length	Description
1	RecTime	14	Date: year month day minute second
2	RecPassNo	2	The code of each gate
3	ReccardID	8	card ID(single or double) , 8digits
4		1	Sign of data uploaded

Computer sends signals to the vehicle access controller to lift the barrier. Then the local database records the date and the gate number. The data recording process is shown in Fig. 5.

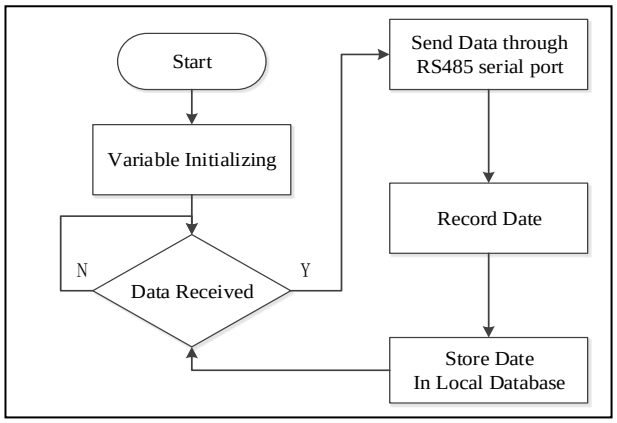

Figure 5. Data recording process

V. THE RUNNING STATUS OF THE VEHICLE ACCESS CONTROLLER

The running status of the vehicle access controller is shown in Fig. 6. If there is no card within the reception range, the controller will be in an idle mode; in the idle mode, the vehicle access controller can still communicates with the computer. The vehicle access controller communicates with the computer by uploading data and receiving instructions. Alert happens when the RFID cards are not within the period of validity or the staff RFID cards doesn't match with the vehicle RFID cards. When there is a special car pass, the privilege of the driver will be checked before the barrier being lifted by the vehicle access controller. The parameters of the

vehicle access controller can be reset through the serial port by computers.

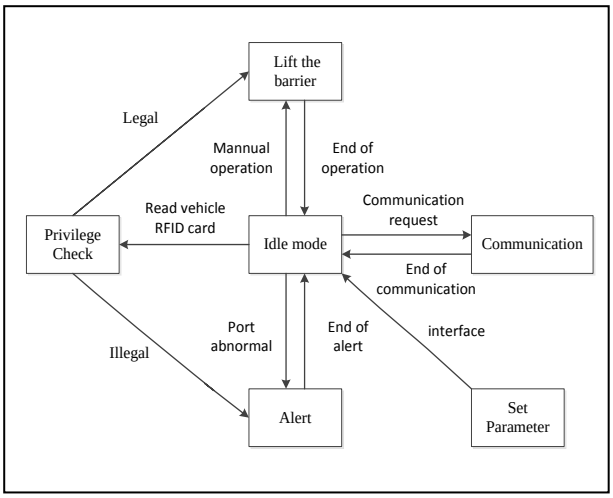

Figure 6. The running status of the vehicle access controller

VI. CONCLUSIONS

A vehicle access control system based on double cards recognition is proposed in this paper to provide a practical solution to put constraints to the behavior of using special cars for private purposes. The network structure and the hardware of the control system have been analyzed. The data structure of the cards is described in detail. The software of dealing with special cars and private cars using RFID cards are introduced. Double cards identifying process is demonstrated. This system is able to meet some special demands in some application fields.

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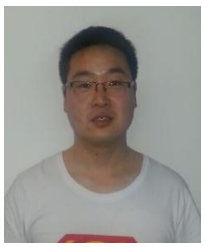

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