

# An intelligent parking system based on GSM module

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**Abstract:** In view of increasing vehicle quantity, this paper introduces a designed intelligent parking system based on GSM module. The system has successfully been applied to GSM network in parking management technology, which makes parking much easier for drivers. A short message could be sent to the system to realize parking easily. The system has several advantages, such as high efficiency, low cost, high security and automatic. MCU and PC are the core of the entire system which control the operation. In short, the system heralds vast potentials for development and considerable market prospects.

**Keywords:** intelligent parking, GSM module, TC35i

## 1 Introduction

With the growth of economy, vehicle has become a necessity in our daily life making the vehicle quantity increase dramatically. Vehicle brings convenience to people, yet parking causes serious problems because of poor management at the same time [1]. For drivers and managers, traditional parking management hasn't met their needs in efficiency, security and performance. Therefore, the need for an intelligent parking system with high efficiency, low cost and high security is indispensable for people in the modern society [2]. Global System for Mobile Communication (GSM) is a digital mobile communication network which has developed rapidly in recent years [3]. It is used widely in mobile device standards. Because GSM network has almost covered the whole country, there is no need to set up another network when using wireless technology. Consequently, it can reduce the cost of construction and service which heightens economic benefit. Compared to other wireless network technologies, subscribers access GSM network freely, without any limitation. As the most basic business of GSM network, Short Message Services (SMS) has become more attractive than ever before. With SMS we can realize the function of data bidirectional transmission, and its performance is stable. Therefore, SMS provides powerful platform for remote data transmission. At present, in most intelligent parking system, drivers need to take an IC card when entering into a parking lot and read the card when getting out [4,5]. In this paper, we have designed a novel intelligent parking

system based on GSM module, it is easy to operate and people with cell phones can use it without any difficulty. Drivers can park conveniently as long as they send a message to the system. The system cuts off complicated operation and makes parking simple, people no longer need to implement complex operation in parking procedure.

## 2 Classification of Parking Lot

### 2.1 Manual mode

It is common in open parking lot or ones with small scale. This kind of parking lot is not only original, but also inefficient. There is no computer or electrical device in the system. All the work is done by staff of the parking lot. Drivers give the money to the staff directly when getting out. Consequently, corruption is common because of lack of supervision. So it can't fit for modern society any more.

### 2.2 Semi-automatic mode

It is the most widely used method right now. Drivers take an IC card where parking information store when entering a parking lot, and then give the card to the staff of parking lot, take charge of payment after reading the card with a machine. It is more advanced than manual mode, but still needs staff to take part in the payment process.

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### 2.3 Automatic mode

It is the developing tendency of intelligent parking system, and also the main point we research on. Drivers send parking application and pay parking fees by sending short message when getting in and out. It is a self-service parking lot without any toll collector, so it reduces the cost and heightens economic profit because of less staff.

## 3 Architecture of Parking System

System frame diagram as shown in Figure 1, the design is divided into several parts including in and out control module, GSM module TC35i, driver's cell phone, data acquisition module and management center. Because entrance control module and exit control modules are similar in hardware structure, we illustrate them as in and out control modules. Sensor include induction coil at entrance and exit, infrared device which is used to detect existence of vehicle. Management center communicate with TC35i via RS232. As indicated in the chart, information is transmitted through GSM network with TC35i module between drivers and parking system.

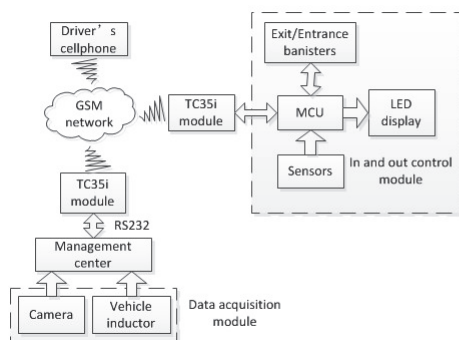


Fig. 1: System frame diagram

## 4 System Hardware Design

In this section, we illustrate the function and composition of every module separately.

### 4.1 Management center

The management center of intelligent parking system is a central control computer which is responsible for coordination and management, including software and hardware settings, state query and database management, etc. Parking information is stored in the central control

computer, for example, vehicle's entering and getting out time, parking duration and fees. It is also convenient for staff to query historical records.

### 4.2 TC35i module

TC35i module is a wireless communication module which is produced by Siemens. TC35i is compatible with GSM 2/2+, dual-band (GSM900/ GSM1800), RS232 data port, accordance with ETSI standards GSM0707 and GSM0705, and easy to upgrade to GPRS module [6]. It provides users with AT command interface standard for data, voice, fax and short messaging. So it is more fast, reliable and secure when transmitting data with TC35i.

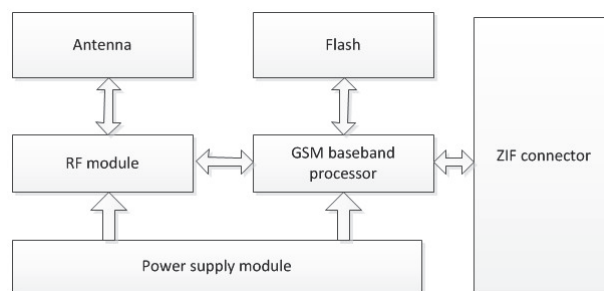


Fig. 2: Block diagram of TC35i

As shown is Figure 2, TC35i consists of six parts: GSM baseband processor, antenna, RF module, flash, power supply module and ZIF connector. As the core of the whole module, GSM baseband processor controls the transmission, conversion and amplification of various signals. RF module and antenna mainly realize the modulation and demodulation of the signals, the conversion of external RF signals and internal baseband processor signals. Power supply module provides processor and RF module necessary power. ZIF connector provides interface of power, data input and output. It should be noted that it will automatically shut down if the supply voltage of the module is less than 3.3V. When launching, the peak current of module can be up to 2A. In this current peak, the voltage of power supply (the voltage sent to the module) decreased value can't exceed to 0.4V. Therefore, the power supply requirement of the module is extremely high. When receiving short message from network, TC35i notify MCU with signal. Meanwhile, MCU and PC send commands to TC35i via serial port.

### 4.3 In and out control module

This module is composed of MCU, LED display, exit/entrance banisters, sensor. MCU is STC89C52 which

is a low power 8-bit CMOS microcontroller. It is a 8-bit single-chip microcontroller with a fully compatible instruction set with industrial-standard 8051 series microcontroller. There is 64K bytes flash memory embedded for application program, which is shared with In-System-Programming code. In-System-Programming (ISP) and In-Application-Programming (IAP) support the users to upgrade the program and data in system. There are 256 bytes on-chip RAM embedded that provides requirement from wide field application. In addition, it has three 16-bit timer/counter, Timer 2, a 8-sources, 4-priority-level interrupt structure, on-chip crystal oscillator and a one-time enabled Watchdog Timer. Therefore, STC89C52 can provide a flexible, effective solution for embedded application. There is a led display both at the entrance and exit which is a dot matrix display screen. It has the characters of high brightness, low operating voltage, low power consumption and long life. The screen use red led lamps so that driver can see it clearly in daytime. LED display at entrance mainly shows the number of total and vacant parking space. Besides, it will display forbidden parking information when there is not enough vacant parking space. LED display at entrance and exit are different, the latter display the time when vehicle entering and getting out of parking lot, parking duration and fees. Exit/Entrance banisters restrict the access of vehicle that is not permitted. Because exit and entrance banister are similar, so we take entrance banister for example. To avoid rising banister when receiving a wrong message, infrared device and induction coil are deployed outside the banister. The entrance of vehicle is permitted only if MCU receive signals which come from sensor and TC335i at the same time. In order to avoid destruction caused by falling down of the banister while vehicle is going through the entrance, there are infrared device and induction coil inside the banister. It won't fall down until MCU receive signals from these devices. Every time the banister rises, the number of vacant parking space will reduce 1 at entrance, similarly, the number of vacant parking space will add 1 when the banister rises at exit. All the number will display on both LED display screen. Data acquisition module consists of camera at entrance, exit and garage, vehicle inductor. Cameras are used to record the color, profile, license plate of the car, they play an important role in security. Staff can inquire all the record which is stored in management center. Vehicle inductor is deployed in every parking space. If parking space is vacant, indicator lamp will turn green so that drivers can know where the vacant parking space is. If parking space is occupied, the lamp will turn red.

## 5 System Software Design

The key point for software design is programming on MCU and TC35i.

AT Command	Function
AT+CSCA	SMS service center address
AT+CMGF	Select SMS message format(0=TEXT, 1=PDU)
AT+CMGS	Send SMS message
AT+CMGR	Read SMS message
AT+CMGD	Delete SMS message
AT+CMGC	Send an SMS command

Table 1: AT Commands

### 5.1 TC35i software design

TC35i realize transmission and reception of short message with AT command in the whole system. AT commands are developed by Nokia, Ericsson and Motorola together for GSM, including the control of SMS, it provides an interface between mobile platform and data terminal. In this paper, AT commands are used to communicate between microcontroller, TC35i modules and management center. AT commands which is used is shown in Table 1. There are two kinds of data format when sending short message: Text mode and PDU mode. Text mode is easy to operate, but doesn't support Chinese. PDU mode is most widely used in the world. It supports both English and Chinese, so the system adopt PDU mode.

### 5.2 MCU software design

The main program is in charge of initializing MCU and TC35i, refreshing LED display and sending parking application to management. Besides, MCU write AT commands to TC35i so that the module can log on the network and read message. MCU controlling flowchart is shown in Figure 3. MCU will test whether TC35i log on network successfully or not after initialization. If it is failure, then initialize TC35i again till success. MCU is waiting until receiving an application. Then read the SIM message and send the information to management center when there has vacant parking space. Finally, the vehicle is allowed to enter the parking lot and the system is waiting for another application.

## 6 System Procedure Design

In this section, work procedure is shown briefly in Figure 4 and Figure 5. The entire procedure includes two parts: check in process and check out process.

### 6.1 Check in process

As shown in Figure 4, infrared device and induction coil will send signal to MCU when a car prepares to check in. Drivers need to send a short message to TC35i of the

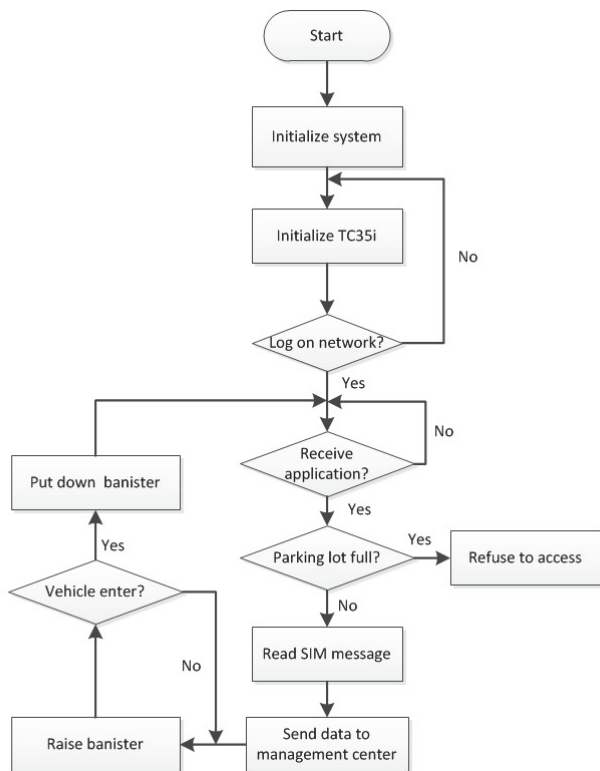


Fig. 3: MCU controlling flowchart

control module. After receiving a parking application, the system will forbid vehicle to check in if there is not enough vacant parking space. In order to avoid the situation that banister rise by mistake. It will rise only if MCU receive signals which come from induction coil, infrared device and TC35i at the same time. If the module doesn't detect vehicles, banister won't rise even if drivers have sent a message to the system. At the same time, MCU will send parking information to management center and all the information store in the management center. When the vehicle has gone through the banister, the banister will be put down. So check in process has been implemented.

### 6.2 Check out process

Figure 5 shows the check out process. It is similar with check in process. Drivers send a message to the out control module. The system confirms that there is a car at the exit, then will send a short message to the driver which includes consumption information, such as parking duration, parking fees. LED screen will display consumption information at the same time. The system deducts parking expenses from mobile account.

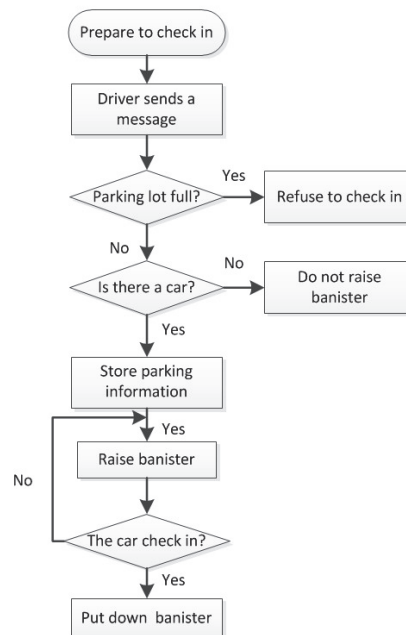


Fig. 4: Parking lot check in process

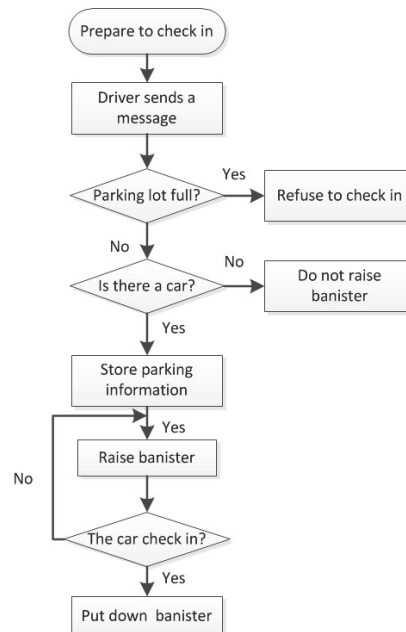


Fig. 5: Parking lot check out process

## 7 Conclusions

The paper introduced a designed novel intelligent parking system based on GSM module. Compared with traditional parking system, it is a real sense of intelligent parking system and brings people with convenience, high stability

and practical utility. A cell phone can realize self-service parking easily. However, there still arise some difficulties in the system. For example, it needs to cooperate and coordinate with mobile operator when deducting expenses. Besides, as known, data loss occurs sometimes during transmission, so it is the biggest problem we need to solve now. Next, we intend to improve the procedure and make it perfect so that the system can be widely used in the society.

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