Design and Implementation of Bluetooth Smart Lock System for Vehicles

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Abstract

In view of the inconvenience of carrying and the single function of the traditional vehicle lock key, a smart phone-based bluetooth smart lock system is designed. The use of smart phones as keys to unlock the vehicle lock system, which greatly facilitates the key to carry. We can give the vehicle's virtual key to others through the mobile phone application. Those people who had get the key can unlock the vehicle by the virtual key. It enriched the function of the key. The test results show that the car bluetooth smart lock system can operate normally in different environments. The problems that vehicle's virtual key is inconvenient to and single function are well solved.

Keywords

Smartphone; virtual key; bluetooth.

1. Introduction

With the update and iteration of bluetooth technology, bluetooth is more and more widely used in intelligent internet devices. In this background, vehicle's bluetooth smart lock system came into being. First of all, a traditional vehicle lock system's key is a single individual, in which case there will be a situation where both the key and the mobile phone need to be carried. But, we can see that the two items are obviously very inconvenient to carry. Secondly, when someone needs to use your vehicle, you must borrow your vehicle's key to them. There may be some unnecessary troubles on the way, such as the loss of the key or theft. The application scene in the literature[1] is only in the smart home. Although the key is more convenient to carry than the traditional key, there are some limitations in the application. In this paper, the bluetooth lock system is applied to the vehicle, and the key of the lock integrated into the smartphone application, unlocking the vehicle lock by the mobile phone. Using the AES encryption for the data transmitted between the vehicle and the smart phone terminal can not only solve the inconvenience of carrying the key of the traditional vehicle lock, but also ensure the security. There is a lack of the function of transferring the virtual key In the literature[2]. In this paper, the virtual key is delivered through the application of the smartphone in order to avoid the possible loss or theft of a key which may occur during the borrowing of your vehicle. When necessary You can also retrieve the key.

2. Vehicle Bluetooth smart lock system overall design

The system includes the micro-controller system of the vehicle lock, the user and vehicle background management system, the mobile terminal mobile application and the wireless communication system that realizes these three connections. Through the socket protocol to achieve smart phone terminal and background management system communication; smart phone through bluetooth and vehicle lock

close communication; thus the vehicle lock, management system, mobile phone applications, the three together, as shown in Figure 1 Show.

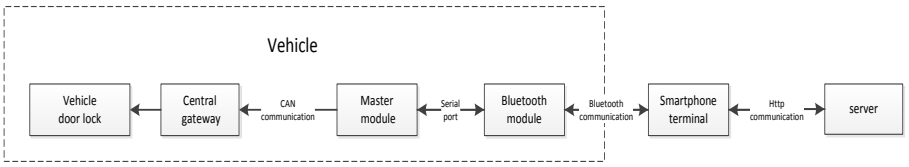

Figure 1 System block diagram

Mobile terminal application is a key part of the whole system. It sends an unlocking instruction to the bluetooth module through bluetooth communication. The main control module converts the bluetooth message into a CAN message and reaches the vehicle lock controller through the forwarding of the central gateway during the entire unlock action. Smartphone terminal also has the electronic key authorization function. Users log in their own accounts, then all vehicles that can be used are displayed. You can put the corresponding vehicle's electronic key through the background server assigned to other accounts. We can add and delete users and vehicles in background management system.

The design of the hardware system requires that each module have the function of low power consumption. So this system use TI's CC2541 as a bluetooth module, responsible for the data communication with the mobile terminal; use NXP's LPC1768 as the master module, responsible for the data processing and forwarding.

3. Vehicle Bluetooth smart lock system software design

Lock system software designed by the lock software, smart phone terminal application software and background management system consists of three parts. The lock software is mainly responsible for receiving the broadcast signal of the mobile phone and establishing a connection and checking the unlock password. After the connection is established within 3ms, the unlocking signal sent by the mobile phone is received, so as to unlock the mobile application software.

Mobile smart phone applications have many features, such as login, unlock, lock, assign and retrieve vehicle virtual keys and other functions. First, the user needs to get all the vehicles under this account in the mobile phone application, and then select the corresponding vehicle to unlock the vehicle lock. Users need to use the vehicle to borrow with others, only need to share the appropriate vehicle keys to other people's account.

3.1 Lock software design

When unlocking the door, first enable the bluetooth protocol stack, initialize the broadcast parameters and send the broadcast, next, send a connection request to the smart phone, if the connection is successful, then you can unlock. Lock software block diagram shown in Figure 2.

3.2 smartphone terminal application software

Smartphone terminal application is mainly responsible for detecting the bluetooth state, bluetooth start and stop scan. The results of scan to obtain, create and disconnect the bluetooth connection and the lock data transmission, virtual key distribution. The specific state transformation shown in Figure 3.

First, the user gets all cars through his or her account. All the cars are displayed in the garage, which are distinguished by the blue and gray signs. Blue represents the user's vehicle and gray represents the authorized vehicle. Click one vehicle’s connection button, start to unlock, no matter unlock success or failure, the application will make the corresponding prompt to the user. Garage interface shown in Figure 4.

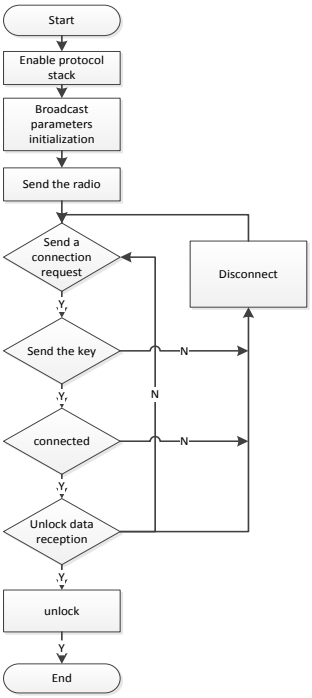

Figure 2 Lock software design

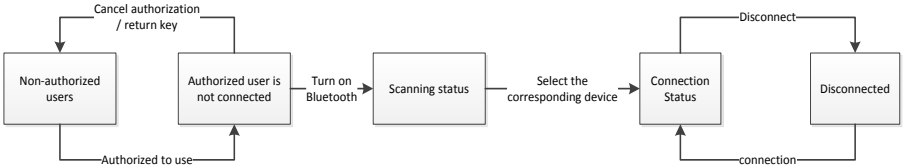

Figure 3 State transition diagram

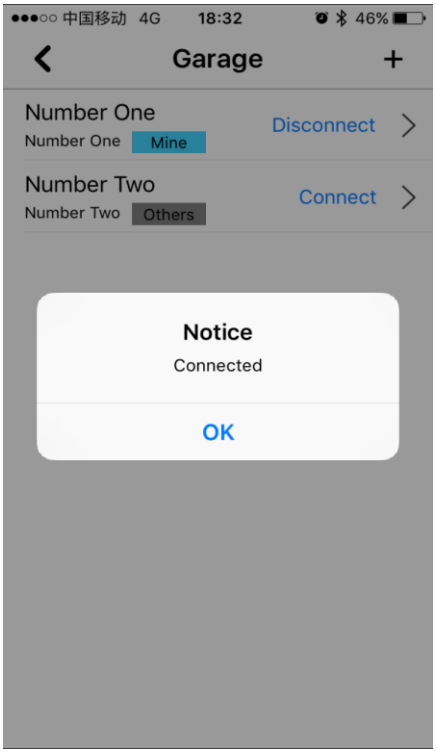

Figure 4 Garage interface

Bluetooth smart lock virtual key authorization function, the user in their own vehicle management interface select the appropriate vehicle, and then own the vehicle authorized to other users. When you

do not need to use the vehicle, the authorized user clicks the return key, or the owner cancels the authorization state, the authorization is canceled.

4. Vehicle Bluetooth smart lock system security design

Due to the special nature of network applications, network security features are very important. In order to ensure the safety of the system, encryption technology must be used. Bluetooth's security model uses secure mode 2-data signature and mutual authentication mode. Because wireless network communication is in an open environment, the data transmitted can be easily intercepted by a third party to disclose the user's privacy. The data transmitted between the handset and the vehicle is encrypted using AES (Advanced Encryption Standard). The data transmitted between the mobile terminal and the background management system is encrypted using the MD5 (Message Digest Algorithm). In this way, even if the data is intercepted by a third party, it is not afraid of the content leaked by both parties. This makes the system's security is guaranteed.

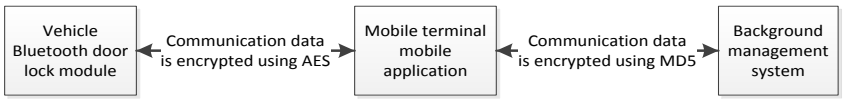

Figure 5 Data Security Design

5. System Test

The main section in the test is the bluetooth communication between the smart phone terminal and the vehicle lock. Simulate daily unlock environment to do the test. First, use the USB-Dongle to grab the data of bluetooth communication for analysising, and then test the communication distance and the corresponding packet loss rate, the connection time of scanning, the response between sending and receiving data through the location of the mobile terminal node time. Test program to set the terminal device nodes in the network loop to send data to the bluetooth module. The test packet contains the serial number of the packet, the start of the packet and the end of the packet. The bluetooth module records the receiving time and sequence number of the first packet of the test packet. When receiving the last packet of data, calculate the connection time. Data sending and receiving interval, packet loss rate and so on. After repeated testing, within the effective distance, the system can send and receive normal data. Test results shown in Figure 6, from the figure we can see that from sending requests to receive the response time interval of about 0.6s, send and receive data normal. After the user authorizes the key to other users, they can receive the corresponding unlock key on the mobile phone. After the authorization is canceled, other users do not have permission to use the vehicle. Therefore, the system can operate normally.

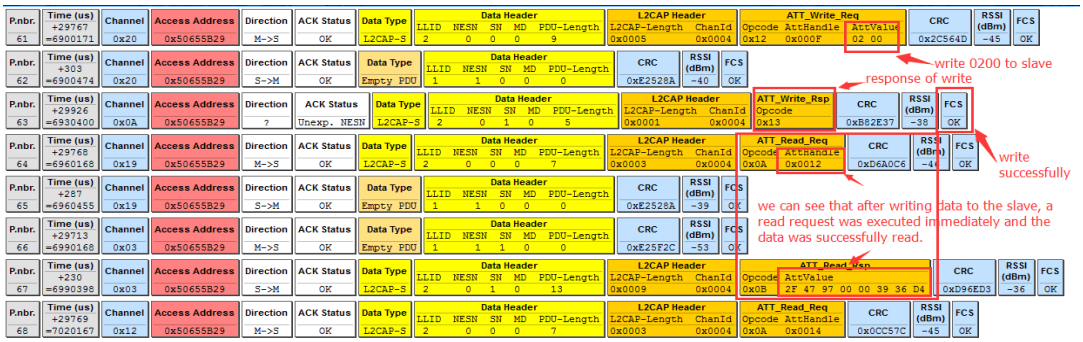

Figure 6 Test results

6. Summary

In this paper, the existing car lock system is analyzed, aiming at the defects of the system, a bluetooth smart lock system is designed. Vehicle access lock using microcontroller and radio in one CC2541 as the main chip. Mobile smart phone as a key to unlock and lock vehicle, share the virtual key to other

people. Finally, use USB-Dongle to capture the bluetooth communication data and analysize some parameters, including response time, scan time, data integrity and so on. The test results show that: for the vehicle bluetooth smart lock system proposed in this paper, not only to achieve a portable, feature-rich features, and data integrity, and high security. Although the application of this system is in the automotive field, the whole system has universal applicability and can be applied in the fields of smart wearable devices, consumer electronics, smart home and so on. Therefore, the design and development staff in the use of the proposed vehicle intelligent lock system, each module can make the appropriate changes to meet the needs of different scenes.

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