Design of Intelligent Fingerprint Lock System Based On STM32

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Abstract. This paper designs an intelligent fingerprint lock management system based on STM32. The system consists mainly of two systems, including the bicycle lock system and the APP access system. The bicycle lock system includes fingerprint recognition, power monitoring, dual positioning of GPS and base station, data transmission and other functions, which is the core of the whole project. The APP system provides the bicycle status to the users, such as display position and riding track. The unlocking method and the function of positioning query make the system more intelligent, anti-theft, novel and convenient.

Introduction

With the advent of digitalization, networking, and information, more and more items in life are labeled as "intelligent." From the birth of the world's first analog computer in 1930, to smart phones, unmanned applications. The ubiquitous intelligence meets the needs of our lives and has become an inevitable trend in the development of science and technology.

In recent years, there have been more and more bicycles and electric vehicles on the market, and the types of locks have emerged in an endless stream. The commonly used locks are mainly the following (here mainly refers to the locks of bicycles and electric vehicles): First, the traditional bicycles have their own locks. This lock is simple in structure and is installed on the rear seat of the bicycle. In this case, it can be opened easily and disassembled easily. The second type, soft lock, also known as steel cable lock, mainly connects the bicycle with other fixed objects. Most of them are unlocked with a key, but can be easily cut by a special shelf, and the security is not good. The U-lock is firmer than the soft lock, but it is too bulky and inconvenient to carry. Shared bicycle is a common transportation tool at present. Its car lock is also embedded in wireless mobile communication, GPS and other modules. Users can scan the QR code to use the bicycle, which is convenient and quick. However, the two-dimensional code of the lock is extremely easy to be destroyed. Based on this, we have studied an intelligent fingerprint lock system, which combines intelligent equipment and human physiological fingerprints, uses GPS+BDS positioning and multi-base station positioning method to track, query and locate, GSM network for remote control, and supporting mobile phones. The management system on the APP not only enhances the security of the lock, but also protects the privacy of personal items.

Technology Route

Introduction to the overall technical route. The intelligent fingerprint lock management system is mainly composed of two subsystems: the bicycle lock system and the APP access system. The main
technical process block diagram is shown in Figure 1. The system mainly uses STM32 as the main control board. Through the TCP data connection, the fingerprint module and other data information are transmitted to the server for background data management. The main control board communicates wirelessly with the bicycle lock installed to the seat. The fingerprint identification system is mounted on the handle of the bicycle, and the lock is opened after fingerprint verification. If the fingerprint verification fails, the bicycle lock automatically alarms and the lock is closed. The positioning module is embedded inside the lock, and the position, state and cycling track can be checked on the mobile APP.

**Fig. 1 System structure diagram**

**Bicycle Lock System.** The bicycle lock system, including fingerprint recognition, power monitoring, GPS positioning, data transmission and many other functions, is the core of the entire project [1]. The specific research contents include: Bluetooth wireless communication between fingerprint module and bicycle lock; GSM module realizes data transmission between mobile phone and car lock; dual positioning of GPS+BDS and base station; power supply for bicycle lock and real-time detection of power [2]. Its hardware schematic is shown in Fig. 2.
Fingerprint module. The bicycle lock mainly uses a capacitive fingerprint module including a fingerprint sensor module and a fingerprint processing module, and its working principle is shown in Figure. 3 (The principle is to integrate the capacitive sense into a chip. When the fingerprint presses the surface of the chip, the internal capacitive sensor generates a fingerprint image according to the difference in charge generated by the peaks and troughs of the fingerprint) [3]. After connecting it, put the finger on one side of the module integrated capacitive sensor, send the instruction to record the fingerprint, record the fingerprint into the database of the module, complete the fingerprint acquisition, and then control the fingerprint module through the STM32 single-chip microcomputer, when the sensor detects a fingerprint on the sensor, it compares it to the fingerprint stored in the database. If it matches, the lock is successfully opened. Otherwise, the buzzer sounds an alarm, and the bicycle lock automatically sends an alarm message to the user's mobile phone APP through the integrated GSM module to prompt the vehicle to be abnormal [4,5].
**Positioning module.** The bicycle lock position uses dual positioning of GPS, BDS, and combines the mode of multi-base station positioning. Due to GPS (Global Positioning System, a satellite navigation system established by the United States, enables users to achieve all-weather, continuous, real-time 3D navigation and speed measurement on a global scale. In addition, the system enables users to perform high-precision time. Transfer and precise positioning with high precision.) is a receptive positioning system with high positioning accuracy and wide global coverage, but communication is not possible. BDS (BeiDou Navigation Satellite System, China’s self-developed global navigation and positioning system) is lower than GPS in positioning accuracy, but can carry out SMS communication and target positioning between two or more parties [6]. It receives the data information of GPS and BDS at the same time, and analyzes the deviations such as satellite clock deviations, orbit deviations and receiver clock deviations to improve the positioning accuracy. Using the multi-base station positioning method, and the multi-base station positioning is generally applied to the mobile phone user, and the location information of the mobile terminal user is obtained through the network of the telecommunication mobile operator. GPS, BDS and base station positioning can be used for precise positioning outdoors or indoor positioning.

**Power Module.** The internal power supply of the lock can be powered by a voltage regulator module (with display) and the power is detected. The input of the power module is connected to some pins of the STM32. The current input voltage and output voltage can be displayed on the display. The current input voltage can be used to determine the amount of power.

**APP access system.** The mobile APP mainly realizes the real-time transmission of the server data, remotely controls the bicycle lock, accepts the alarm information, and displays the vehicle position and the previous riding trajectory on the mobile phone end. Using the Android Studio integrated development environment, the user login is first performed on the APP interface. After successful login, the navigation interface is displayed to display the parking position of the vehicle and the status of the vehicle. It is also possible to display the riding track after riding, as shown in Fig. 4.

![Fig. 4 APP flowchart](image)

**Conclusion**

This paper introduces the overall design of the intelligent fingerprint lock system and the functions of each module. In general, the combination of the bicycle lock system and the APP is adopted, the unlocking method is novel, safe and intelligent, and the anti-theft property of the non-motor vehicle is also improved. Using GPS and base station dual positioning to facilitate querying vehicle location. With the development of science and technology, intelligent locks have become an inevitable trend to replace traditional mechanical locks, and have a broad application prospect.
References


