Design and Implementation of a Single Button Operation for a Door Lock Control System Based on a Near Field Communication of a Smartphone

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***Abstract*—This design integrates the near field communication (NFC) reader of a smartphone device with the door lock control system to provide a convenient single button operation. This design also offers three operation modes to the user in order to allow a one-time password with a time stamp permission to match the user's password to thus enhance the door's security. The door lock control system is fixed on the door, and also provides both the sleep state and the standby state to save power consumption for a long time operation.**

***Index Terms*—Smartphone, Near Field Communication (NFC), Time Stamp, Door Lock Control System, One-Time Password (OTP)**

I. Introduction

In recent years, smartphones equipped with NFC communication technology have brought convenience and have gradually changed the human way of life [1]. For example: people can use the smartphone's NFC communication technology in access control security, in addition to the traditional radio frequency identification (RFID) technology, contactless access cards, and electronic tags, all of which can be used to open a specific door [2] [3] .

This design provides a reliable, simple and fast operation mode by which a user simply clicks a smartphone button to verify the password and open the door. In addition, the user can also choose to either use the numeric keypad mode to enter a password, or to use a teaching guide mode to open the door.

II. Hardware Architecture

Figure 1 shows the hardware architecture of the door control system which consists of a buzzer, an infrared module, a magnetic lock, a real time clock module, a NFC reader module, and a MCU.

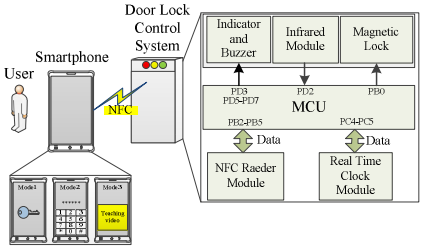

Fig. 1. The hardware architecture of the smartphone NFC and the door lock control system.

III. Software Design Implementation

The software design consists of a smartphone operation mode selection, password authentication, and door lock control system state transitions. This software design uses the NFC Data Exchange Format (NDEF) [4].

A. Smartphone Operating Selection Mode

Figure 2 shows the flowchart of the smartphone selection mode. When the user selects the first mode, which is a single button mode, the user simply presses this button and can quickly verify the user's identity ID and password. When the user selects the second mode, the numeric keypad, and the door lock control system identification identity ID, the identification is completed. Then the user first can obtain a password, next, enter the password using the numeric keypad, and then open the door. When the user selects the third teaching guide mode, a teaching video guides the user both how to operate the smartphone to identify the identity ID, and how to key in the password to open the door.

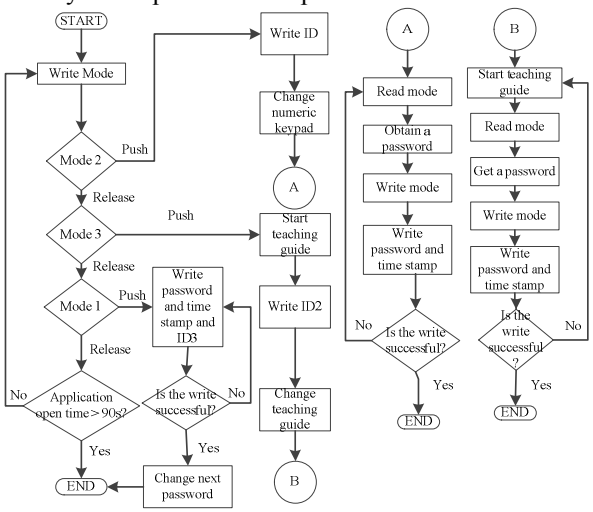

Fig. 2. Smartphone operating selection mode flowchart.

B. Password Authentication

Our design uses the concept of a one-time password. When a password is verified, the design will automatically switch to the next set of passwords for authentication. This mechanism prevents a password from being reused.

C. Door Lock Control System State Transition

Figure 3 shows the door lock control system sleep state transition, which is used in order to perceive smartphones placed on the door control system. When the user first uses this state, this design must switch the sleep state/standby state to the active state. The user interface is divided into three operation modes: the first is the single button, the second is the numeric keypad, and the third is the teaching guide. When the user clicks the single button mode, the software module identifies the user's password.

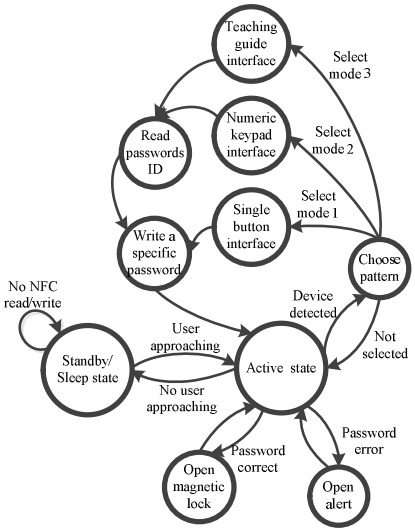

Fig. 3. Door lock control system state diagram.

IV. Experimental Results and Comparison

This design provides three operation modes: a single button, the numeric keypad, and the teaching guide which requires an operation time of 2, 20, and 40 seconds respectively. A single button operation mode requires 2 seconds, which is the shortest operation time, thus allowing users to quickly open the door.

Figure 4 shows the three operation modes of the smartphone interface which are a single button, the numeric keypad, and the teaching guide. In addition, the door lock control system circuit provides the operation of the door lock control system.

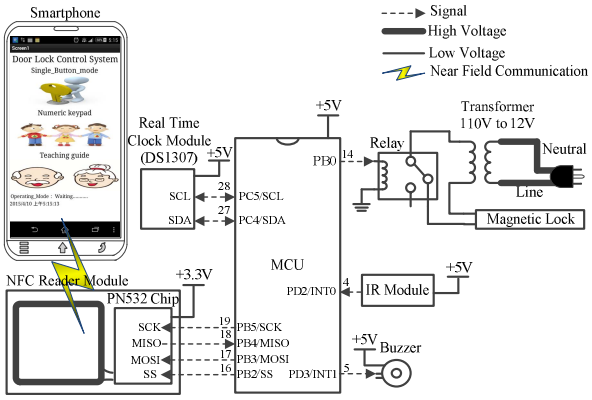

Fig. 4. The smartphone interface and the door lock control system circuit.

Table I shows the power consumption of each module in this design. In order to save the power consumption for a long period of time, this design uses a sensor and a low power MCU to control both the standby and the sleep state, Hence, this design consumes only 227.45mW which is even less power in comparison with other door control system designs.

TABLE I. The Power Consumption of Each Module of This Design

Power Consumption	Standby/Sleep State	Operating State
Buzzer	0.55mW	210mW
NFC Reader Module	158.4mW	528mW
Infrared Module	53.5mW	63mW
Real Time Clock Module	12mW	12mW
MCU	3mW (Sleep)	73.5mW
Total	227.45mW	886.5mW

Table II shows the comparison of this design and other systems. Design A and B are used for the remote server which will encrypt and decrypt messages. Design A is used to store the coded pictures, to send them to the remote server, to decode the picture coding, and to obtain the password. Design B, the password authentication, consists of the use of public key encryption/decryption, and the obtaining of a password from the remote server. This design uses the password with a time stamp. A one-time password can also be realized and used to improve security. In addition, the single button design reduces the burden on the average smartphone consumer.

TABLE II. A Comparison of This Design with Other System Designs

	Design A [2]	Design B [3]	Previous Design	This Design
Time stamp	No	No	Yes	Yes
One Time Password	No	No	No	Yes
Convenience	Low	Low	Low	High
Security	High	Low	High	High
Cost	High	High	Low	Low
Power consumption	High	High	Low	Low

V. Conclusions

This design, a smartphone NFC door lock control system, provides a low power, secure, convenient way both to open and to lock a door. This design also offers three smartphone operation modes which provide a way for different users to communicate with the door lock control system.

References

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