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SMARTPHONE ACTIVATED DOOR LOCK USING WIFI

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ABSTRACT

A smartphone has variety of uses and becomes one of the most important devices nowadays. This paper describes the design and operation of a door locking using smartphone through Wireless Fidelity (WiFi) technology. Programmed using Android, the smartphone can lock and unlock the door within WiFi range. Android application is designed using Eclipse and a Peripheral Interface Controller (PIC) is used as the main controller of the design. This design is able to work within maximum range of 40 meters and 150 meters. Smartphone activated door lock using WiFi has been designed, implemented and tested successfully.

Keywords: smartphone, door lock, WiFi, android, and PIC.

INTRODUCTION

Nowadays, the capability of smartphones is astonishing. A Smartphone is capable to handle applications that can perform a wide variety of functions. The purpose of this project is to simplify the tasks of locking and unlocking the door and to increase the security of the door locking system. The design used solenoid lock and Peripheral Interface Controller (PIC) as the main parts. The WiFi module and PIC are placed inside the home, apartment or building which is next to the door. The design will be managed through the Android application in the smartphone to unlock and lock the door automatically. The proposed design is also user friendly, where there is a reset button inside house to allow user to exit the door during emergency situation.

Recently, a lot of researchers have developed a technology based home security and automation. The authors in [1] have developed application for controlling access cabinet using Microsoft SQL Server Management Studio for managing the database of the users. This design requires a server which is costly but useful in office area where a controlling system is needed to control people accessing the cabinet.

In [2-3], the authors discussed the ongoing project using Bluetooth technology to control the access of the door locking using Android and Arduino. By using Bluetooth, the door locking system only can be accessed within shorter range compared to WiFi technology.

OVERVIEW OF THE DESIGN

Figure-1 shows the block diagram of the proposed door locking design. The block diagram consists of one transmitter and one receiver. Both of them are communicating using WiFi standard, which is IEEE 802.11. In this design, an Android smartphone with WiFi access is functioning as the transmitter. The receiver parts consist of a PIC, WiFi module, relay, and solenoid door lock. When the correct IP address and port number are received, the solenoid lock will be activated and it will unlock the door for 5 seconds. Besides, there is a reset button to unlock the door from inside the house. This is useful for emergency exit especially for home owner.

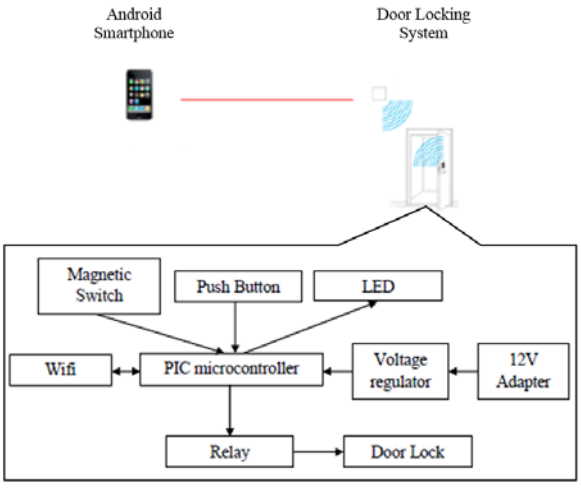

Figure-1. Block diagram.

The development of this project consists of software and hardware implementation. Two main soft wares used in this design are Eclipse for building the Android application and C language for PIC to control the door locking. As for the hardware part, the design of the door lock was chosen carefully in order to increase the security of the door locking besides saving energy. In this project solenoid lock was chosen where the lock design is focused to an electrically operated door system that has high reliability. The locking mechanisms are holding a latch keeper in locking position to prevent opening of the door. This condition of system revealed that the solenoid is in unlocked position when it is energized and does not require electricity when solenoid is in locked position [4]. Thus this situation leads to electric saving characteristic design.

This project concentrates on Android application. The Android Development Kit (SDK) [5-7] is used where it provide libraries needed to interface with hardware.

Android system architecture is the Android that created on top of the open-source Linux 2.6 Kernel. The Android team chooses to use this Kernel. It provides a proven core features to develop the Android operating system.

HARDWARE CONFIGURATION

Figure-2 shows the schematic diagram for the receiver part. PIC16F877A consists of 40 pins but only 33 I/O pins can be set as digital input or digital output which can be used to control the whole design. The PIC able operate from 4.5 VDC to 6 VDC. By using voltage regulator LM7805, the voltage is stepped down to 5 VDC. The WiFi module used in this project is XBee WiFi module [8] where it provides low power and low cost solution by offering simple serial to IEEE 802.11 connectivity.

The frequency band for the chosen WiFi module is 2.4 GHz. This band can transmit power of more than 15dBm and cover ranges of up to 120 meters. The relay output is a single pole double throw (SPDT) which its coil can be energized using 5 V and de-energized using 0 V. Initially, the relay output is normally closed. When the input coil of relay is energized, the output will switch to normally open. The switching is used to control device which is less than 250 VAC and 10 A. The LED is used as an indication for door opening or closing. When the output is low, the door is lock and both LED are OFF and vice versa.

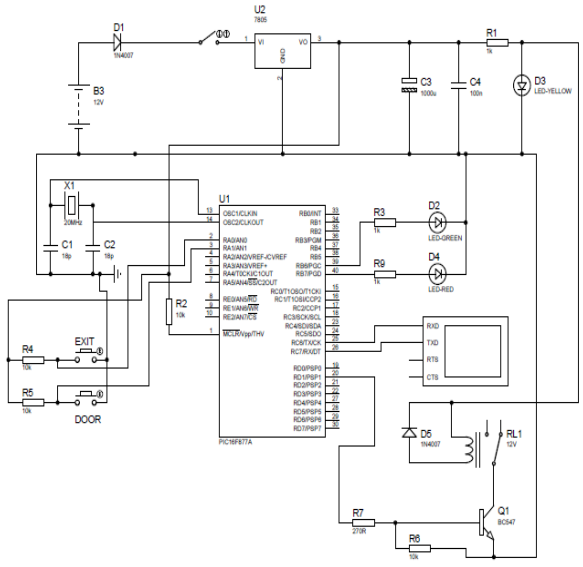

Figure-2. Schematic diagram.

Proteus 8 is used to design the schematic diagram and the corresponding PCB layout. The PCB layout of the door locking is shown in Figure-3.

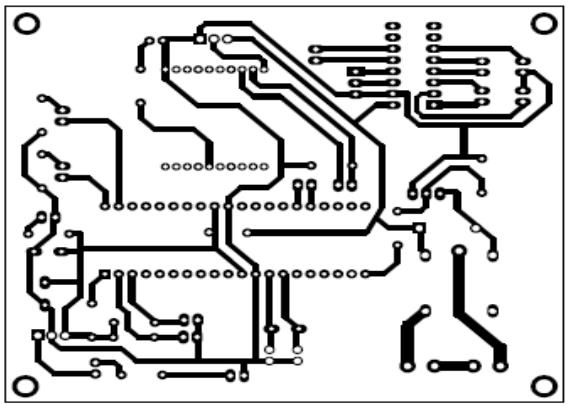

Figure-3. PCB layout.

SOFTWARE CONFIGURATION

The flowchart of the project is shown in Figure-4. The door will unlock if it receives the correct password or the exit button is pressed. When the microcontroller detects the data 'A', the output pin D1 become high and the door is unlocked and the magnetic switch will be opened. After 5 seconds, the door will lock automatically and the magnetic switch will be touching each other.

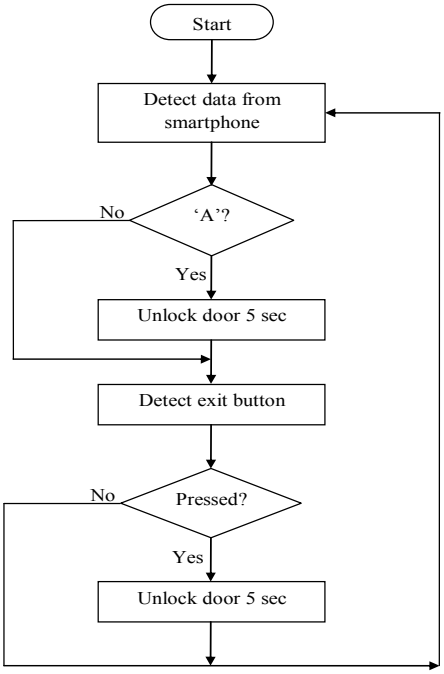

Figure-4. Door locking flowchart.

The source code when the WiFi data is detected is shown in Figure-5. In Figure-6, if the exit button is pressed, the output pin D1 will also become high and that indicates the door is unlocked. Pin A1 becomes high when the door is open. At this time, pin B6 becomes high and pin B7 is low. Lastly, when the door is closed, pin D1 and

B6 becomes low. The purpose of the push button is to make sure people from inside the house can unlock the door without using smartphone especially during emergency situation.

```
do
{
    if(kbhit()) //if wifi data detected
    {
        mydata1=getch();    //get data1
        mydata2=getch();    //get data2
        mydata3=getch();    //get data3
    }

    if(mydata2=='A')
    {
        output_high(pin_d1);   //unlock door
        delay_ms(5000);
        mydata2=0;
    }
```

Figure-5. Codes when WiFi data detected.

```
    if(input(pin_a0)==0 && a0_on==1) //if exit button pressed
    {
       output_high(pin_d1);  //unlock door
       delay_ms(5000);
       a0_on=0;
    }
    else if(input(pin_a0)==1)
    {
       a0_on=1;
    }

    if(input(pin_a1)==1) //if door open
    {
       output_high(pin_b6);  //on green led
       output_low(pin_b7);  //off red led
    }
    else  //if door closed
    {
       output_low(pin_d1);  //lock door
       output_low(pin_b6);  //off green led
       output_high(pin_b7);  //on red led
    }

}while(1);
```

Figure-6. Codes for exit button.

RESULT AND DISCUSSIONS

Figure-7 shows the circuit on Printed Circuit Board (PCB) together with the WiFi module used in this project. The PCB is attached next to the door to control the operation of the door lock. The Android application is shown in Figure-8. The Android application interface is designed to allow user to key in the IP address and port number according the IP address of the WiFi. The user can unlock the door after connected with the design within maximum range of 40 meters and 150 meters.

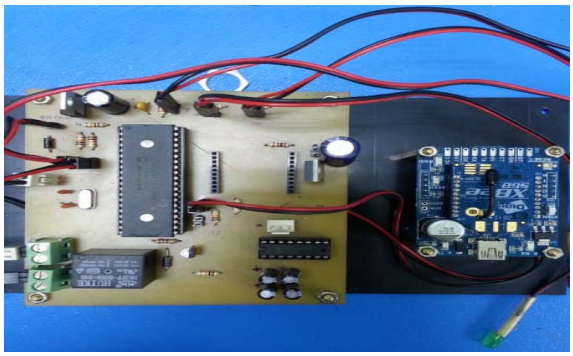

Figure-7. Circuit on PCB board.

Analysis was conducted to test the performance of the design at indoor and outdoor as shown in Figure-9. Based on the graph for both measurements, as the distance is increasing, the delays are increased as well. For outdoor analysis, the connection between smartphone and WiFi is lost after 150 meters due to the WiFi limitation range while for indoor analysis, the connection between smartphone and WiFi is lost after 40 meters. Fewer obstacles observed for outdoor analysis which effects in better results compared to indoor analysis. Obstacles reduce the effectiveness of the WiFi transmission due to path loss [8]. This design works better in less obstacles work environment.

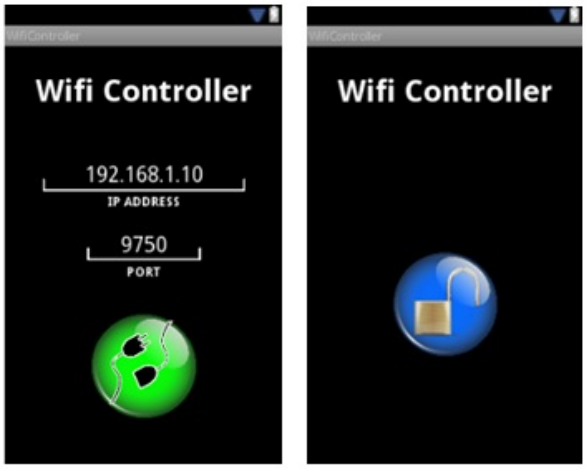

Figure-8. Android application interface.

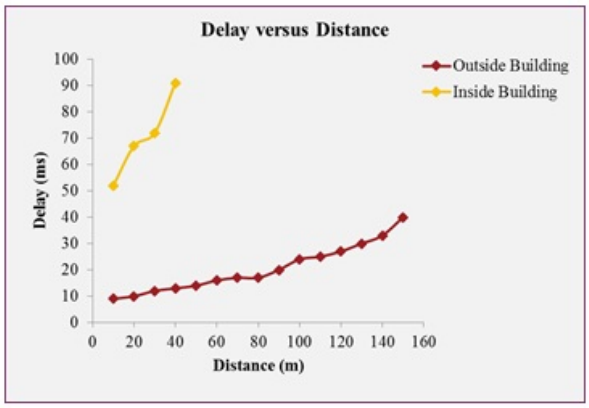

Figure-9. WiFi performance.

CONCLUSIONS

Smartphone activated door locking using WiFi has been designed, implemented and tested successfully. This design used a smart phone to lock and unlock door wirelessly using WiFi technology. In future, the existing relay can be replaced with solid state relay (SSR) to reduce the power consumption and increase the stability of the design. Furthermore, security features can be added to increase the efficiency of the design. This could be done

by introducing application protocol encryption in future. Last but not least, the Android application interface can be further enhanced to ease the user in case they could not remember the IP address and port number.

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