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ELECTRONIC ENGINEERING

Microcontroller-based Password-protected System for Security-demanded Applications

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Abstract— **Security systems are vital components in safely ensuring of one's environment. These systems are important features of modern homes, offices and the buildings. Security depends on access control systems or methods. Nowadays, many types of access control system have been developed for home and industrial applications. Some of these are voice recognition system, identity card system, code system and biometric system. Level of security and installation cost differ from one system to others. Each system has its own advantages and disadvantages. In this paper, microcontroller-based password-protected system which is very simple to implement and the most cost effective one is presented.**

Keywords— **Security, access control system, level of security, installation cost, password-protected system**

I. INTRODUCTION

Security is the prime concern in our day-to-day life. Everyone wants to be as much secure as possible. So security control systems play vital role in modern technologies. More advanced technologies have been ever demanded in the area of security control technologies. Discovering the more and more efficient control technology becomes a challenging matter. Due to many efforts and researches made in the field of security control techniques, today security control systems are very intelligent and give satisfactory results. But every system has pros and cons and no exception for these systems. The more advanced the system is, the more it costs. Speaking in the medical point of view, some systems operated in the very high frequency are hazardous to the health and pollute its associated environment. And some systems cause interference to most of the electronic devices. In this paper, password-protected security access control system is presented to overcome these drawbacks. Although the code-protected security control system is not as secure as the biometric system like eye scanning, it is still critical in daily-life security-demanded applications because of its cost-effectiveness and ease of use. Moreover it is user-friendly and does not pollute the environment. The proposed system is very straightforward and easy to implement. The block diagram of the password-protected security access control system is shown in Fig. 1. The power supply unit is for providing the required power for the whole system. Peripheral Interface Controller PIC16F877A produced by Microchip Technology is used as a main controller in this system. PIC microcontroller is selected because of its powerful features and its rich resources. Economically, it has low cost compared to other products. A four by three matrix keypad is used for entering the password. Keypad is the simplest form of electronic access control. Matrix keypad is a type of Human-Machine Interface (HMI) with numerical or function keys. A Liquid Crystal Display (LCD) is used for displaying the condition of the entered password and required information. Alarm unit is for alerting that an intruder or an illegitimate person is trying to gain access to the system. Output signal will be activated when user enters the correct password. This means that user will gain access to the system.

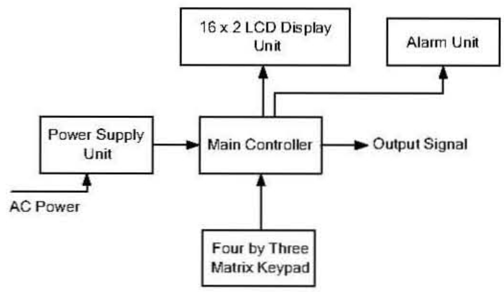

Fig. 1 Block diagram of microcontroller-based password-protected system

II. OPERATION OF THE SYSTEM

When the system starts up, the LCD will display the text 'WELCOME TO YOU'. After that, the LCD will display the message 'SECURITY SYSTEM'. Then the microcontroller reads the stored password in its EEPROM location showing the message 'READING EEPROM' on the LCD. It stores the read password into RAM location. Then, the LCD will display the message 'ENTER PASSWORD'. At this time, the user can input the password by pressing the keys on keypad. While entering the password, the message 'SCANNING KEYPAD' will be displayed on the LCD. The entered password is stored into another RAM location. Two special characters '#' and '*' are used. The key '#' is used for 'ENTER' key and the key '*' is used for changing the password. The entered password is compared with the stored password. When the controller is comparing the passwords, the LCD will display the message

'COMPARING CODE'. If the entered password is correct, and the last character is '#', the user will gain access to the system showing the message 'ACCESS GRANTED'. If the user inputs more than nine digits, only the last nine digits will be valid. Green LED is used in this system just for showing that the specific task is being executed. After five seconds time is up, the LED will turn off. If the entered password is incorrect, the user will be prohibited to access the system showing the message 'ACCESS DENIED'. The controller will give the user the next two chances to enter password. If the user enters incorrect password for three times, the controller will give an alarm notifying that the user is an illegitimate person. Alarm will continue until the power supply is cut-off. If the user wants to change password, the correct password together with the key '*' must be entered. At that time, the LCD will display the message 'CHANGING CODE'. Then, the LCD will display 'ENTER PASSWORD'. The user must enter the new password and the special character '#'. Then, the LCD will display the message 'CONFIRM AGAIN'. The user must input the new password again together with the special key '#'. The controller will compare the next new password with the previous password. If they are not same, the password in EEPROM will not be changed showing the message 'CHANGING FAILED'. If they are same, the new password will be written into the EEPROM location. The user must use the new password to access the system at the next time.

III. SOFTWARE IMPLEMENTATION FOR THE SYSTEM

The program development phase plays very important role in implementing embedded systems. In developing the program, it must be sure that no programming or logical errors present in the program as the whole system solely depends on the program. In this system, MPLAB Integrated Development Environment (IDE) software developed by Microchip Technology is used for developing the program and assembly language, one of the high level programming languages, is used as the programming language. Utilizing the rich resources of PIC, EEPROM data reading and writing techniques, indirect memory accessing technique and software debouncing technique are applied to this system. For systems with fewer than thousand of instructions, a useful aid is to represent the algorithm by means of a flowchart. Fig. 2 shows the main flowchart for access control system. The main program is composed of many subroutines or procedures. Each procedure is created for specific functions or tasks. Critical subroutines contained in this main program are explained in detail with respective flowcharts.

A. Scan Procedure

It is used for scanning the user's input and saving this in the buffer, and passing the data concerned with the input to the respective section of the program. Keyscan procedure for sensing which key is entered is nested in this procedure. Readchk_enter subroutine, a nested subroutine of scan procedure, is for checking whether the special keys, '*' for code change and '#' for enter, are pressed or not. The scan procedure also makes the last nine digits of the entered password valid if the user enters more than nine digits because the system password length is only five digits. To read the keys pressed, the program requires the switch debouncing. This means that the delay of approximately 20 to 30 milliseconds is needed between button presses. This part is required to allow the key hits to settle for a few tens of milliseconds before establishing a firm contact. In this program, 24 milliseconds delay is used for debouncing. The flowchart for scan procedure is shown in Fig. 3.

B. Readchk_enter Procedure

This procedure checks the keycode from RAM register locations whether the last character is the same as '#' key or '*' key. If it is '#' key or '*' key, it will return with zero flag bit of status register, Z = 1. Otherwise it will return with Z = 0. The flowchart for this procedure is shown in Fig. 4.

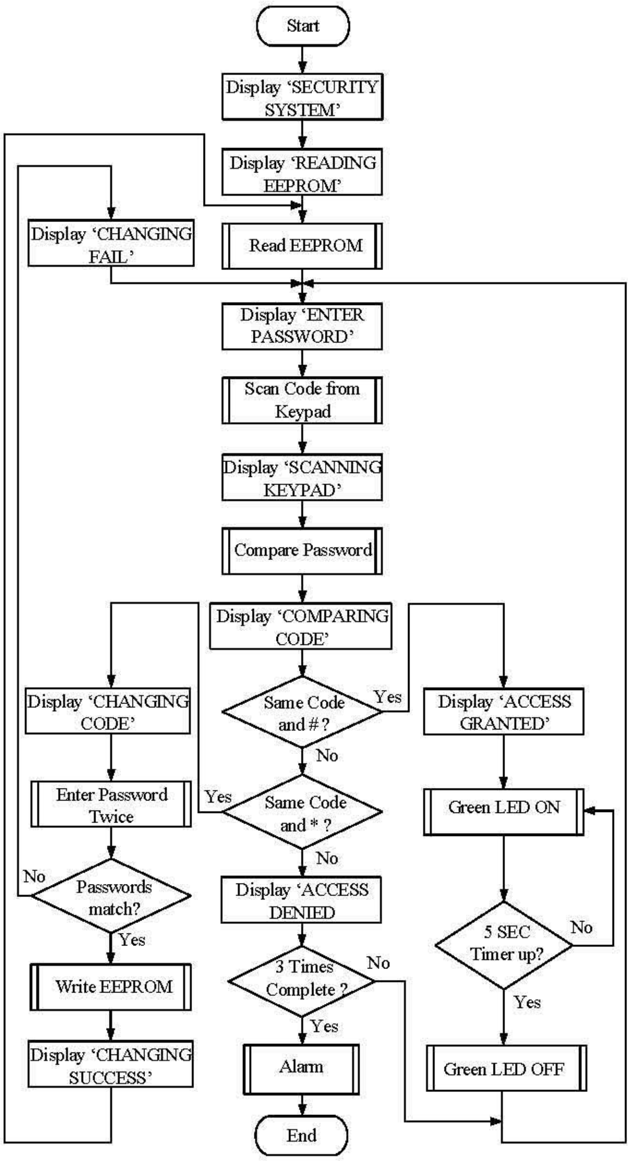

Fig. 2 Flowchart for the overall system

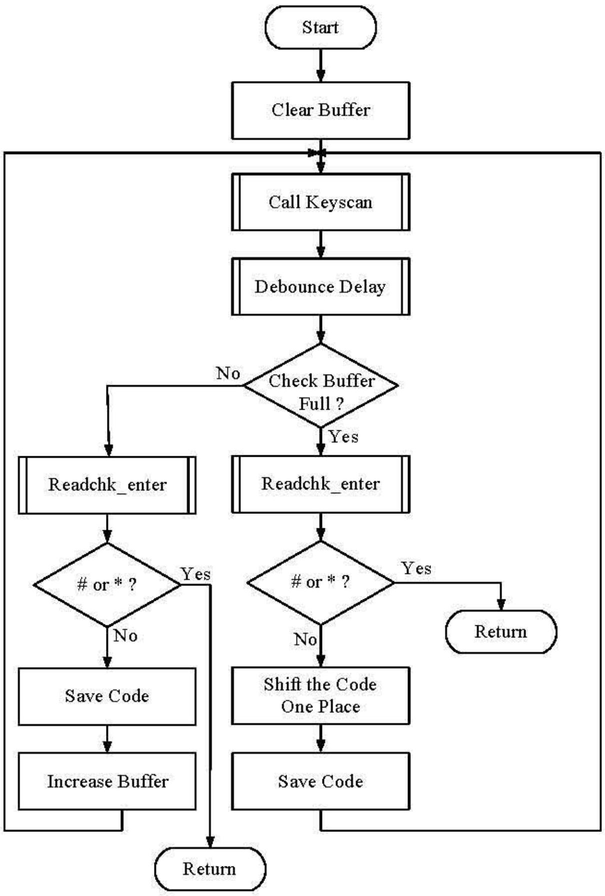

Fig. 3 Flowchart for scan procedure

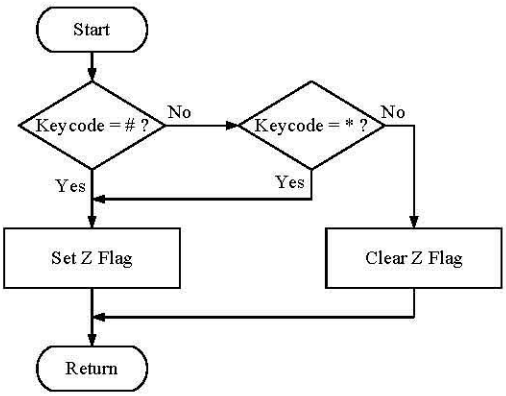

Fig. 4 Flowchart for readchk_enter procedure

C. *Combuf Procedure*

Compbuf procedure is created to compare the code from RAM locations with the entered code in read buffer. In other words, this procedure checks whether the user's entered codes and the stored codes in the microcontroller. When the user wants to change the password, it checks the confirmation password whether they are same or not. If they are same, it will return with Z = 1, otherwise Z = 0. The flowchart for compbuf procedure is shown in Fig. 5.

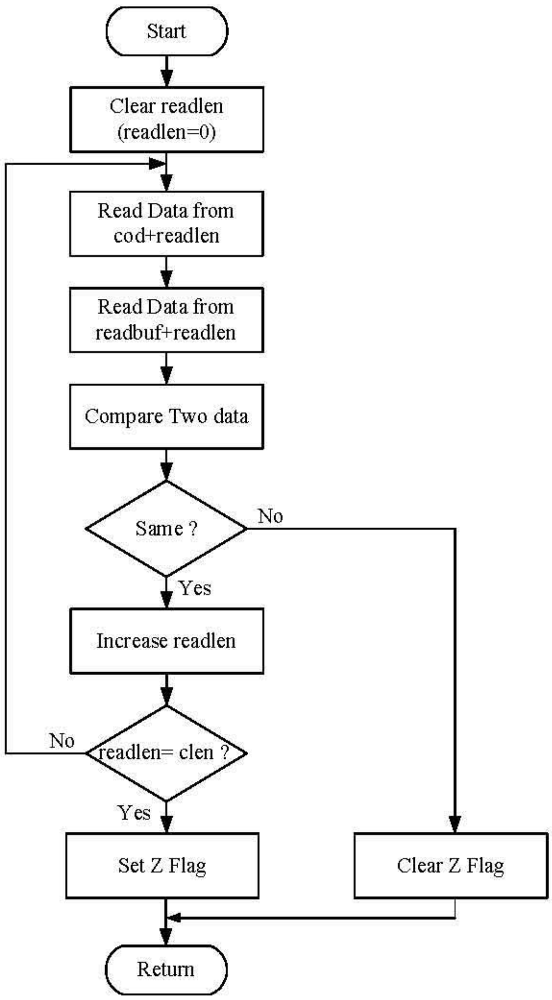

Fig. 5 Flowchart for combuf procedure

IV. Hardware Configuration of the System

By utilizing the efficient resources of the PIC, the circuit of the whole system is very compact and very simple. If power supply is not taken into account, all necessary components in this circuit are just only keypad, LCD, 4 MHz crystal oscillator, LED, buzzer, a general purpose transistor, two ceramic capacitors and some resistors. The entire circuit diagram is shown in Fig. 6.

V. Door Access Control System

Door access control system is presented here just for an example as one of the applications of the proposed system and for giving the idea how the proposed system can be employed for the desired application areas. Just modifying the system a little, password-protected door access control system can be implemented. In this system, door will be opened if the password is correct and automatically closed after a reasonable time delay. In this system, time delay is set to 10 seconds. The alarm will be activated if the password is entered incorrectly for three times. The schematic circuit diagram of the application example is illustrated in Fig. 7.

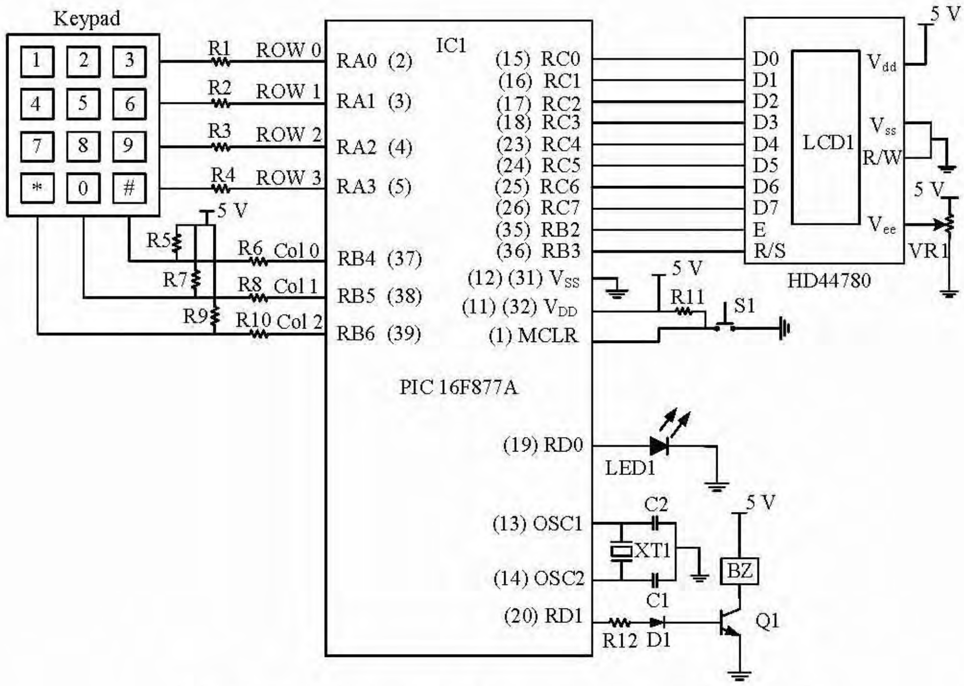

Fig. 6 Schematic circuit diagram of the password-protected security system

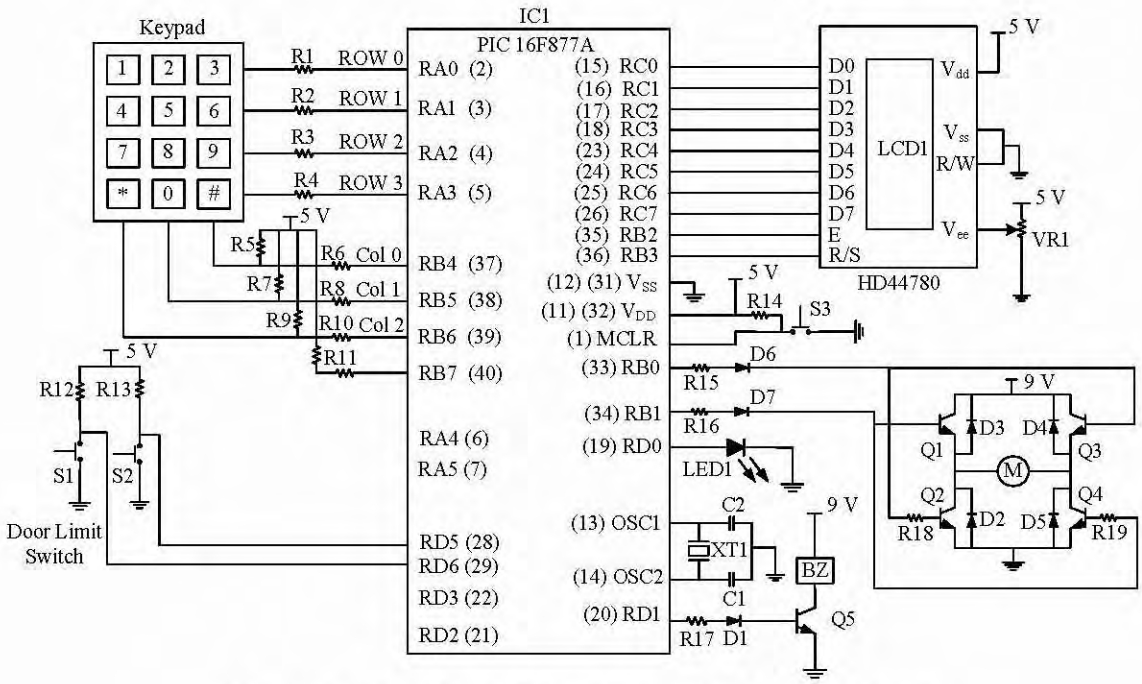

Fig. 7 Schematic circuit diagram of the code-protected door access control system

VI. Simulation and Experimental Testing

Simulation is necessary for monitoring the expected results. In this paper, simulation is performed by using ISIS software, the product of Labcenter Electronics. It is a very powerful tool for developing the embedded system designs. This product combines mixed mode circuit simulation, microprocessor models and interactive component models to allow the simulation of complete microcontroller based designs. So, it provides the means to enter the design in the first place, the architecture for real time interactive simulation and a system for managing the source and object code associated with the project. Simulation of the password-protected system is shown in Fig. 8 and simulation of the door access control system is shown in Fig. 9.

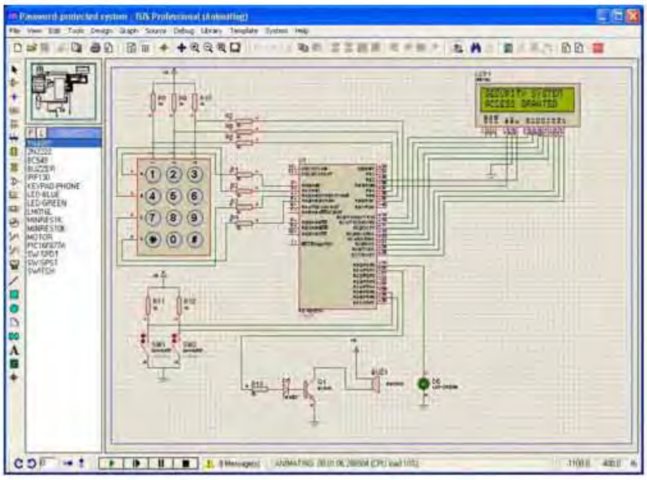

Fig. 8 Simulation of the password-protected system

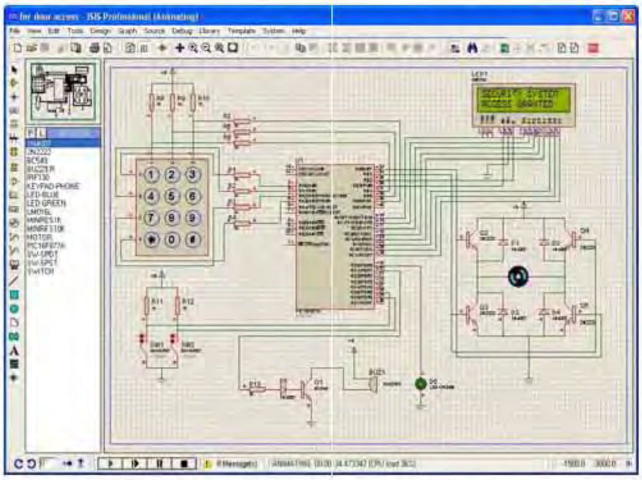

Fig. 9 Simulation of the door access control system

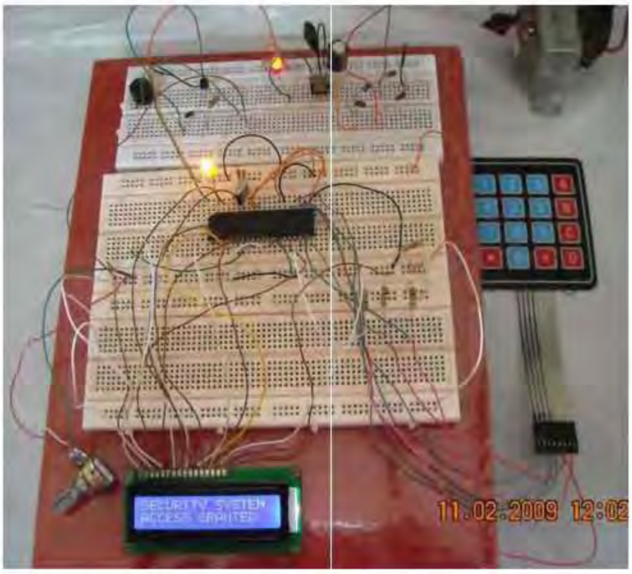

Fig. 10 Experimental testing of the proposed system

Fig. 11 Experimental testing of the door access control system

VII. Conclusion

In this paper, microcontroller-based password-protected system has been presented. How to develop the program necessary for making the system alive has been explained with flowcharts. Assembly programming language has been used for developing the program. The developed program together with the system circuit has been simulated by ISIS interactive simulation software. As this software supports the real-time interactive simulation, the necessary changes in software and hardware can be made even in the developing phase. The circuit of the implemented system is very compact and straightforward as this system is based on the embedded system design. No calculation concerned with the system's circuit design is needed in this system. Only the knowledge of microcontroller and programming idea are necessary to develop this system. As a matter of fact, the system is intended to serve as the backbone for further development in the application areas of security access control systems.

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