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An Effective Home Security System Based on Multimodal Interaction

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Abstract:

Home security system has been a major issue where crime is increasing and people depend on security solutions. Security system with single modal interaction yields diminished authentication. The GSM based security system afford only voice and message communication. CCTV security system gives only image and video clips of visitor. The multimodal interaction security system provides innumerable authentication.

The main aspiration of this project is to develop encapsulated system to increase salvation with the help of many authentication modules. In this project a home security with multimodal interaction has been implemented. GSM system is used to enable voice communication between visitor and the person at home and it also sends message. The system requests the visitor for finger print authentication with the aid of finger print scanner. If the person is authenticated, then message is sent to the person at home and speaker announces the name of the visitor. The wireless camera records the image of the visitor. The person at home can communicate with visitor without opening door.

Keywords: GSM, CCTV, Single Modal interaction, Multimodal interaction

1. Introduction

Home Security System (HSS) means a manner in which objects are secured by using an interconnected components and apparatus. This is an advanced Home Security System which uses Finger Print Scanner for identifying authorized person, GSM system for communication (Voice and Message) between authorized or unauthorized persons and person inside home, Wireless camera for recording video of visitor. This increases the security for home and decreases the crime. With video identification of visitor face becomes easy and with Finger print scanner we get authentication of visitor.

The security system like GSM based home security system provides only voice communication and message service with less authentication of unknown persons. The camera based security system provides only images and video clips of unknown person with less authentication. The disadvantage of this system is the camera receiver must be continuously ON. As a result, there is a high power consumption. The video clip is continuously recorded and stored in a memory. So it consumes more memory and this security system needs large amount of memory for storing video clips.

So to provide high security to home and more authentication of unknown persons a technology can be used and embedded system can be developed which provides voice communication, message service, fingerprint scanning for authentication and camera for recording of video of known or unknown persons which improves the security of home and authentication of person.

2. Proposed System Design

The structure of proposed Home Security System (HSS) is shown in Figure 1. It consists of different modules. The visitor side consists of Switches, Finger print scanner, Speaker, Mic, LCD, Wireless camera. The visitor must press the login switch and place the finger on scanner. During this time the camera receiver automatically turned ON and the speaker guides the visitor step by step. LCD displays the message.

The GSM Sim900A module sends the message to person inside home when visitor finger print matches. The visitor video clip is displayed on display and recorded automatically. Using Accept and Reject switch the person inside home controls the opening and closing of door. The door control is indicated by using LED. If person inside home want voice communication with visitor, he can call using his mobile to GSM SIM 900A module which consists of SIM card. When person inside home calls then the GSM module receives the call automatically and provide voice communication. It picks up the call only from the cell phone of the person who is inside house. The power supply gives various constant voltages for the modules used in HSS. It provides +5V, +4V and +12V.

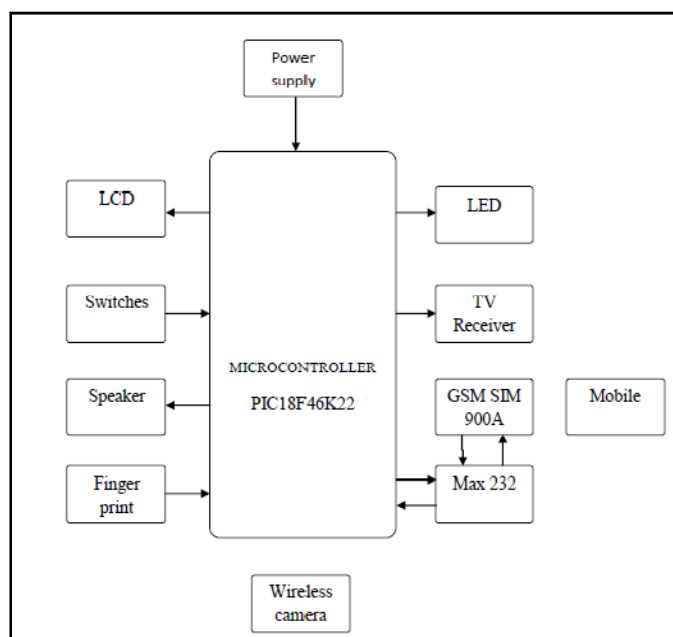


Figure 1: Block diagram of Proposed HSS

3. Hardware Design

The following components are needed for constructing home security system

A. Microcontroller PIC18F46K22

Microcontroller is a programmable device which controls the all activities in system. It is a brain of system. In HSS microcontroller is used. The PIC18F46K22 is a low power, microcontroller with XLP technology from Microchip.

FEATURES	PIC18F46K22
Timers	7
I/O Ports	35
RAM	3.8Kb
EEPROM	1Kb
Interrupt sources	3
Watchdog timer	1

Table 1: PIC18F46K22 Features

B. Fingerprint module R305

Fingerprint processing includes two parts

- 1) Enrolling of finger pattern
- 2) Matching of pattern

In Enrolling process, user enter the finger 2 times. The finger image is processed by the system and generates a pattern of the finger. The pattern is stored. For matching, user place the finger on optical sensor and system generates a pattern of the finger and compare it with patterns of the finger collections. For 1:1 matching, system compares the person finger with specific pattern designated in the module. For 1: N matching, system search the whole library. Finally, system gives failure or success result.



Figure 2: R305 Fingerprint module

C. SIM 900 GSM Module

This module provides GSM Call, SMS and GPRS internet services. It is mainly used for Data and voice communication. It has 8 pins VCC, RXD, TXD, GND, MIC1, MIC2, SPK1, SPK2.

The RXD is connected to RD6 Pin of microcontroller. The TXD is connected to RD7 pin of microcontroller. MIC is connected to MIC1, MIC2 pins. Speaker is connected to SPK1, SPK2 pins of GSM module.



Figure 3: SIM 900

D. APR33A3 Voice recording and playback IC

In HSS APR33A3 voice recording and playback IC is used. It is shown in Figure 2. It records voice message using MIC and sends recorded memo to speaker.

Features of APR33A3 are

- Operating voltage range 3V to 6.5V
- Single chip, high quality, voice recording and playback
- Voice recording length is 680 seconds
- Power full 16-bit digital audio processor
- Nonvolatile flash memory technology
- External reset pin
- 8 voice messages record and playback
- Very low standby current 1 μ A
- Built in audio recording microphone amplifier
- High standard line receiver
- High standard analog to digital and PWM module



Figure 4: IC APR33A3

E. MAX 232 Drivers/Receivers

It is a dual driver or receiver. An example of MAX 232 is shown in Figure 4. The EIA 232 voltage levels supplied by capacitive voltage generator. In HSS each receiver converts inputs to 5V TTL/CMOS levels. The receiver has threshold of 1.3V and hysteresis of 0.5V. it accepts ± 30 V input. Each driver converts input levels to EIA 232 levels.

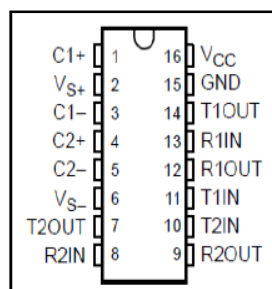


Figure 5: MAX 232 IC

F. LM317 and 7805 IC Regulator

LM 317 is an adjustable IC voltage regulator. Figure 6. displays LM317. It is a 3 terminal positive voltage regulator which supplies 1.5A over an output voltage range from 1.25V to 37V. Pin 1 is an adjust pin, Pin 2 is an output pin and Pin 3 is an input pin. Output of LM317 is connected to Vcc pin of GSM module.

It is +5V IC Regulator. Figure 7 shows the regulator IC 7805. It receives 12V DC from rectifier and gives +5V regulated voltage. It is a 3 pin IC. The output of 7805 is connected to FP module, LCD, Voice IC, Mic, Switch 1, 2, Accept, Reject, Reset. 7805 IC provides +5V.

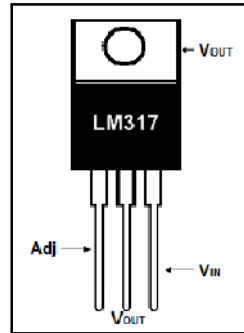


Figure 6: IC LM317

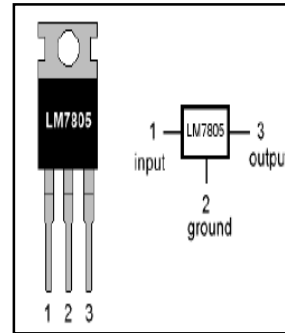


Figure 7: IC 7805

G. Wireless CCTV Color Camera Surveillance

This wireless camera uses radio transmitter and receiver to stream the captured videos. Figure 8 shows the receiver and wireless camera. It can be connected to TV / System. In HSS, wireless camera with 9V battery is installed outside home and receiver is connected to system. It is a night vision camera, real time surveillance. Picture and sound deliver distance is 50 to 100m. High receiver sensitivity, power consumption is less than 400mW, voltage +9V, current 500mA.



Figure 8: Wireless camera and receiver

H. Liquid Crystal Display

It is a display device which consists of 2 lines. Each line prints/displays 16 characters (Alphanumerical). Figure 9 shows the LCD module. In HSS, the D4, D5, D6, D7 pins of LCD are connected to RB4, RB5, RB6, RB7 pins of PIC18F46K22 microcontroller. LCD is operated in 4-bit mode. The following figure indicates 16 X 2 LCD display which is used for HSS. It displays the login information, verification, name of visitor, finger pattern matching.

Features of LCD are

- 5 X 8 dots with cursor.
- Controller
- +5V power supply
- 1/16 duty cycle



Figure 9: Liquid Crystal Display

4. Software Design

Software required for programming PIC18F46K22 microcontroller and Finger print scanner module are SY Demo and MPLAB IDE.

1) *SY Demo*

By using this software, we can enroll new users finger print using windows and finger print scanner module. Using SY Demo software we can enroll new finger prints. First we need to connect sensor module to computer by using USB-serial cable. Select COM port for communication between system and sensor. Baud rate can be changed for data transmission and security level can be changed. The default baud rate is 57600 and security level is 3. For enrolling a new finger, click the preview checkbox and press enroll button. When box comes up, enter the ID number. We can use up to 256 ID numbers. The software asks you to press the finger to sensor.

2) *MPLAB IDE*

It is the new graphical, integrated debugging tool set for all of microchips more than 800 8 bit, 16 bit and 32 bit MCU's and digital signal controllers and memory devices. For developing microcontrollers applications this software is used. It is called Integrated Development Environment (IDE), because it provides single integrated environment to develop code for embedded μ c.

The files and associated files are systematically arranged by project manager. The linker places the object code from the assembler, compiler into the actual memory sector of the embedded controller and guarantee that the module function with each other.

5. Design of Monitoring and Controlling System

If the switch 1 is pressed, then camera receiver is turned ON otherwise camera receiver remains in OFF condition. The visitor must place his finger on FPS and he should press switch 2. If switch 2 is pressed, then system scans visitors finger impression and if the impression is matched then the speaker declares Finger pattern valid otherwise Finger pattern not valid. The camera receiver will be turned OFF.

If the finger pattern is confirmed, then we can use Accept or Reject switch. If Accept button is pressed, then door is opened and it is indicated by LED ON condition and camera receiver if OFF. If Reject button is pressed, then the door is not opened and camera receiver if OFF. Then control goes to starting state. Flow chart for HSS is shown in Figure 10 and Figure 11

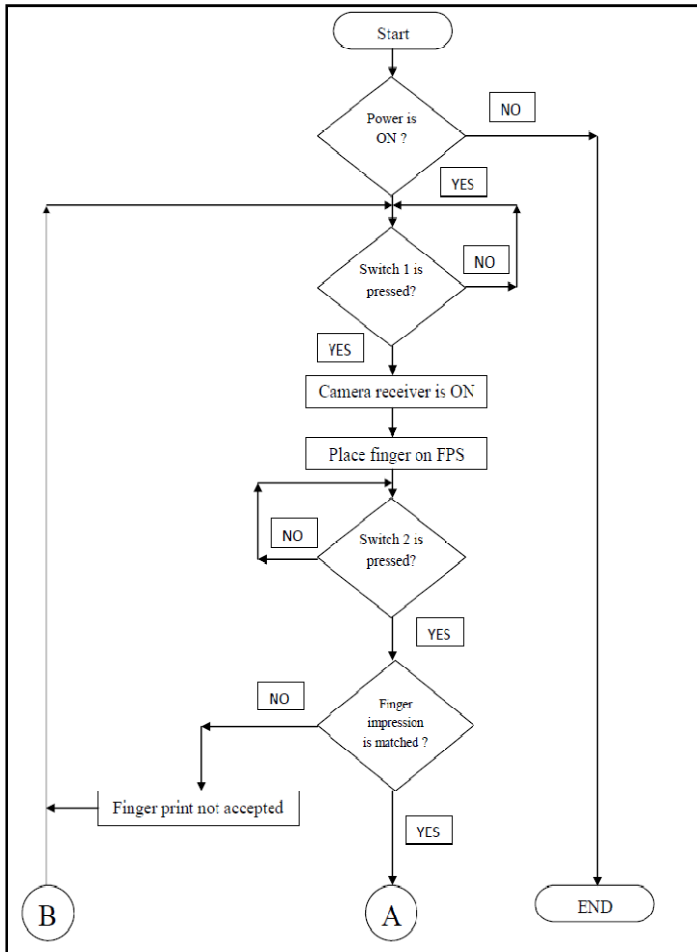


Figure 10: Operation of HSS

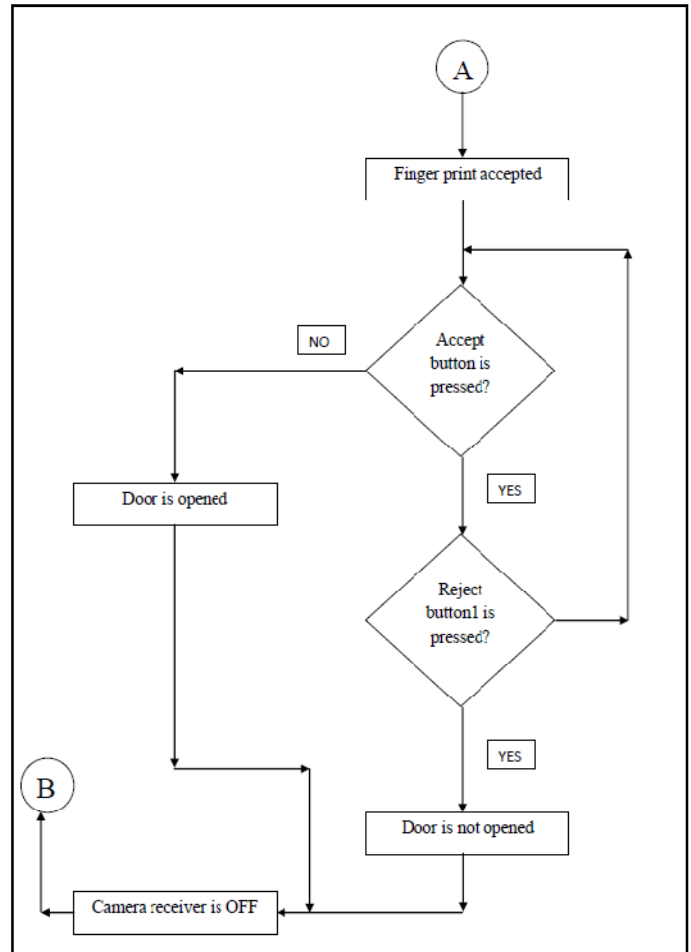


Figure 11: Operation of HSS

6. Experimental and Simulation Results

Examining is crucial for assuring the peculiarity of the creation. It determines the integrity, precision, salvation of the refined embedded compound. This unit enumerates the result achieved from planned job. This Home Security System (HSS) is essential for every home because it gives security to home with accurate authentication by using Fingerprint scanner, GSM module and Wireless camera. The other security system providing only voice communication or recording video clips continuously or controlling home appliances using GSM. Figure 12 shows a model of HSS.



Figure 12: Working Model of HSS

The proposed system can be installed in homes, offices, schools, colleges, VIP homes, offices and restricted area. This HSS is uncomplicated and it is very facile to use. If the visitor finger pattern is validated, then immediately GSM module of HSS sends message to the mobile of the person inside home. And also if the person inside home want to communicate with visitor then he can call to the SIM number which is in GSM module of HSS. This GSM module automatically receives the call. The visitor and person inside home can communicate each other.

This HSS system is more advanced and gives accurate authentication of known or unknown person. The TV receiver is turned ON only when visitor press the switch. Otherwise camera receiver is in OFF condition. So there is a less power consumption of TV receiver compared to other security system. The HSS has many advantages compared to other security systems. In this system the door opening is automatically controlled inside home. The result of HSS is as follows

When the security system is turned ON, then SIM is initialized and TV receiver is in OFF state. The LCD shows the message press switch 1 for login. Whenever the visitor presses the switch 1 then TV receiver automatically turned ON, LCD displays keep your finger on FPS and press switch 2. If the visitor presses the switch 2 and finger print is matched, then LCD shows welcome paper man or milk man etc. During this time message is sent to person inside home. With respect to the operation of HSS, LCD displays the following messages.



Figure 13: Login



Figure 14: Scanning

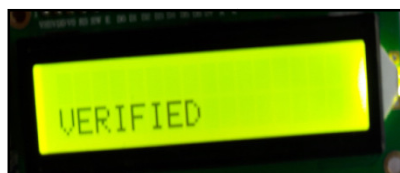


Figure 15: Verification



Figure 16: Authenticated



Figure 17: Waiting for Response

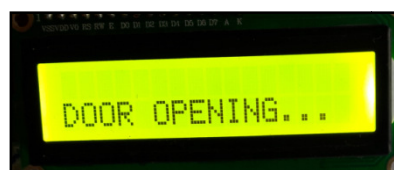


Figure 18: Door Opened



Figure 19: Door not Opened



Figure 20: Not Authenticated

If the Accept button is pressed by the person inside home, then Door is opened and if the Reject button is pressed then Door is not opened. At this time TV receiver is turned OFF. Finger print of the visitor is not matched then LCD displays finger pattern is invalid and try again.

7. Conclusion

Providing security or protection to home and people inside home is very important today's life. If there is no protection, then crime increases. The HSS provides full protection or security to home and people inside home.

This system allows only authorized person to enter home. It provides finger print scanning for checking whether the visitor is authorized person or not. It also displays image or video of the visitor. It sends message to the person inside home. It provides voice communication between visitor and person inside home without opening door. It announces the name of the visitor using speaker. In HSS the voice call is automatically received by GSM module.

8. Scope for Future Work

A module and software can be used to send messages and images of the visitors to nearby police station. A Siren may be used to alert neighbors, if the visitor makes three or more unsuccessful logins.

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