

Design and Implementation of Advanced ARM Based Surveillance System using Wireless Communication

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Abstract—This paper evaluates development of a low cost surveillance system using different sensors built around the microcontroller with fingerprint sensor module. The low power PIR detectors take advantage of pyroelectricity to detect the change in environment temperature through human temperature in our experiment. Also we are using Ultrasonic sensors and vibration sensors. Ultrasonic sensor (Obstacles detection) detects the intruder on their physical presence. Vibration sensors detect sound of breaking or senses vibration signal. Fingerprint sensor module is based on taking fingerprint of the user with the help of fingerprint sensor module and matching it with the database details corresponding to the user fingerprint and displays it on the computer screen. Detecting the presence of any unauthorized person it triggers an alarm and send sms to a predefine number through a GSM modem. This surveillance system has a better percentage of security with respect to other security system available. Apart from this it is fast processing less expensive and better probability, alter and copy of information between source and database.

Keywords— GSM, ARM, PIR Sensor, Ultrasonic Sensor, Vibration Sensor, Fingerprint Module Sensor, RF Tx/Rx.

INTRODUCTION

In a situation where there is high level of theft, there is need for better security system. It is much safer to have a system that monitors and communicates to the device owner without putting human life to risk in the name of “Watchman”. This tends to utilize the availability of GSM network, mobile phone and electronics circuit to achieve an automated system which is programmed to work as a thinking device to accomplish this purpose. To secure it against theft, crime, etc a powerful security system is required not only to detect but also pre-empt hazards. Conventional security systems use cameras and process large amounts of data to extract features with high cost and hence require significant infrastructures. In this paper the alerting sensors with low-power consumption are placed near those home windows and doors where an intruder must pass through. According to the sensor’s signals received by microcontroller, a call is established to mobile station through a GSM modem and thus warns the presence of unauthorized user in the home to owner-occupier. On the other hand, this security system remains in idle position and performs nothing if no one is in the home. This paper is organized into eight sections, including this section. Section II discusses some related works and section III presents a system’s block diagram. Components of hardware and their operation details are in section IV and section V shows software flowchart Advantages and applications are discussed in section VI and finally the conclusions are presented in section VII.

RELATED WORKS

Now a day’s indoor security systems constructed with many and different sensors which included microwave detectors, photoelectric detectors, infrared detectors, and many others. Every of these systems having their own limitations. As an example, photo-electric beam systems detect the presence of an intruder by transmitting visible or infrared light beams across an area, where these beams may be obstructed. But the drawback lies within it if the intruder is aware of the presence of this system. Despite of having strong dependence on surrounding environmental status, pyroelectricity has become a widely used detection parameter because of simplicity and privilege of interfacing to the digital systems. Also ultrasonic sensors are widely use because of their good and relatively fast response. Vibration sensors are also use as they

senses any noise of breaking or sound of vibration. Now, it is extensively used for intruder detection, smart environment sensing, and power management applications. Several works have been conducted in various applications. Intelligent fireproof and theft-proof alarm system [1], GSM (Global System for Mobile) network based home safeguard system [2], human tracking system [3] and intruder detection systems [4] are some notable works done previously based on pyroelectricity and ultrasonic sensing technique. Our work introduces a low-cost security system solution. Utilization of existing cellular network to alert and inform the system owner about the security breach is made to cope up with ever increasing demand for cheap but reliable security system. Also we are using the fingerprint module sensor in combination with other sensors which plays major role. Also using wireless communication this system provides very fast response as compared to the traditional surveillance system.

SYSTEM ARCHITECTURE

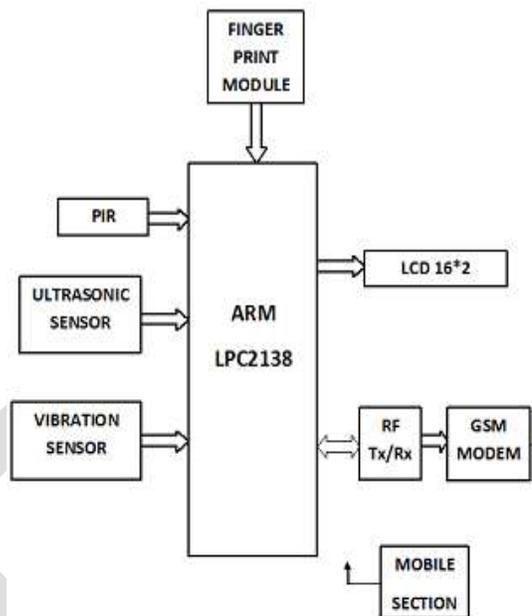


Figure 1. System block diagram

The Fig. 1 shows block diagram of the system. It consist of fingerprint sensor module, PIR sensor, ultrasonic sensor, vibration sensor, ARM processor, RF Tx/Rx Module, GSM Module and liquid crystal display.

COMPONENTS OF HARDWARE

- MICROCONTROLLER

In this project the controller used is ARM7 LPC2138. LPC2138 CPU module is based on LPC2138 SOC from NXP is an ideal platform for applications which such as Industrial control and monitoring device and any such application which needs migration from 8 bit to 32 bit. This CPU module board supports peripherals such as ADC, SPI, I2C, RTC etc.

Board Specification:

1. CPU: ARM7:
 - a) 65 MIPS at 60 MHz
 - b) Embedded ICE, Debug Communication Channel Support
2. Communication interface
 - a) SPI
 - b) I2C
 - c) UART
3. General peripherals:
 - a) 40 GPIO
 - b) 10bit ADC's
 - c) Timer/Counter
 - d) RTC
 - e) Programmable Vector Interrupt Controller
4. RAM:
 - a) 32 KB Internal SRAM
 - b) Flash:
 - c) 512 KB Internal Flash

Add on peripherals for LPC2138 CPU module board

- a) ZigBee module
- b) RF communication module
- c) Thermal printer module
- d) GPS module
- e) GSM/GPRS module
- f) Motor control module

- **FINGERPRINT MODULE SENSOR**

A Fingerprint, as the name suggests is the print or the impression made by our finger because of the patterns formed on the skin of our palms and fingers. It is fully formed at about seven months of fetus development and finger ridge configurations do not change throughout the life of an individual. Each of our ten fingerprints is different from one another and from those of every other person. With age, these marks get prominent but the pattern and the structures present in those fine lines do not undergo any change. Database storage contains the fingerprint templates of persons along with their all details information (e.g. – photo, fingerprint, name, age, sex, identification mark, permanent address etc.). A person can scan their finger on the fingerprint sensor module. If their fingerprint matched with the fingerprints of the database which has made for authorized person, then the person can enter otherwise they will be denied. Database is designed in such a manner that it can be updated manually and automatically for a period of time and also we can add new entry and remove previous information of a person when it needed.

In this system fingerprint sensor module R305 is used. This is module with TTL UART interface for direct connection to microcontroller UART through MAX232 or USB–serial adapter.

Steps involved in Finger print identification:

1. Finger Print enrollment through system.
2. Enrolled user places his/her Finger on the Finger sensor for checking IN/OUT (Authentication).
3. The terminal compares live finger with the finger stored on database and checks for a match.
4. When a match is found the Authentication is successful and the user is given access.



Figure 2. Fingerprint sensor module

Advantages of using fingerprints:

1. Prevents unauthorized use or access
2. Adds a higher level of security to an identification process
3. Eliminates the burden and bulk of carrying ID cards or remembering Pins
4. Heightens overall confidence of business processes dependent on personal identification.

- **PIR SENSOR**

In this security system we are sensing human movements by means of PIR sensors and alerting the security and owner simultaneously using GSM wireless network. PIR sensors are low cost, low power small components used to trigger alarm in presence of human or moving objects by using concept of Pyroelectricity. Pyroelectricity is the ability of certain materials to generate a temporary voltage when there is change in temperature. PIR is basically made of Pyroelectric sensors to develop an electric signal in response to a change in the incident thermal radiation.



Figure 3. PIR sensor

- **ULTRASONIC SENSOR**

Ultrasonic sensors work on the similar principle to the radar or sonar which evaluates attributes of a target by interpreting the echoes from radio or sound waves respectively. Ultrasonic sensors generate high frequency sound waves and evaluate the echo which is received back by the sensor. Sensor calculates the time interval between sending the signal and receiving the echo to determine the distance to an object and display it on the LCD. Fig.3 shows diagram of ultrasonic sensor.



Figure 4. Ultrasonic sensor

- **VIBRATION SENSOR**

The ADXL335 is a small, thin, low power, complete 3-axis accel-erometer with signal conditioned voltage outputs. The product measures acceleration with a minimum full-scale range of ± 3 g. It can measure the static acceleration of gravity in tilt-sensing applications, as well as dynamic acceleration resulting from motion, shock, or vibration. The user selects the bandwidth of the accelerometer using the CX, CY, and CZ capacitors at the XOUT, YOUT, and ZOUT pins. Bandwidths can be selected to suit the application, with a range of 0.5 Hz to 1600 Hz for the X and Y axes, and a range of 0.5 Hz to 550 Hz for the Z axis. The ADXL335 is available in a small, low profile, 4 mm \times 4 mm \times 1.45 mm, 16-lead, plastic lead frame chip scale package (LFCSP_LQ).

Features

- 3-axis sensing
- Small, low profile package
- 4 mm \times 4 mm \times 1.45 mm LFCSP
- Low power : 350 μ A (typical)
- Single-supply operation: 1.8 V to 3.6 V
- 10,000 g shock survival
- Excellent temperature stability
- BW adjustment with a single capacitor per axis
- RoHS/WEEE lead-free compliant

Applications

- Cost sensitive, low power, motion- and tilt-sensing applications
- Mobile devices
- Gaming systems
- Disk drive protection

- Image stabilization
- Sports and health devices

- RF Tx/Rx MODULE

An RF Module (Radio Frequency Module) is a (usually) small electronic circuit used to transmit and/or receive radio signals on one of a number of carrier frequencies. RF Modules are widely used in electronic design owing to the difficulty of designing radio circuitry. Good electronic radio design is notoriously complex because of the sensitivity of radio circuits and the accuracy of components and layouts required achieving operation on a specific frequency. Design engineers will design a circuit for an application which requires radio communication and then "drop in" a radio module rather than attempt a discrete design, saving time and money on development. The RF Tx/Rx module will receive the signal from microcontroller and send message to the predefined number through GSM module. Here we are using CC2550 module which is low cost 2.4 GHz transmitter designed for very low power wireless application. The RF transmitter is integrated with a highly configurable baseband modulator. The modulator supports various modulation formats and has a configurable data rate up to 500kbaud.

- GSM MODULE

GSM (Global System for Mobile communication) is a digital mobile telephony system. With the help of GSM module interfaced, we can send short text messages to the required authorities as per the application. GSM module is provided by sim uses the mobile service provider and send sms to the respective authorities as per programmed. This technology enables the system a wireless system with no specified range limits. When the intruder is detected by surveillance system the sms is send to the predefined number through the GSM. In this system GSM SIM 300 module is used.



Figure 5. GSM Modem

Features of GSM simcom300-

- i. Designed for global market, SIM300 is a Tri-band GSM/GPRS engine.
- ii. Works on frequencies EGSM 900 MHz, DCS 1800 MHz and PCS 1900 MHz.
- iii. SIM100 features GPRS multi-slot class 10/ class 8 (optional) and supports the GPRS coding schemes
- iv. CS-1, CS-2, CS-3 and CS-4. With a tiny configuration of 40mm x 33mm x 2.85mm
- v. SIM100 can fit almost all the space requirements in your applications.
- vi. Such as smart phone, PDA phone and other mobile devices.

Applications GSM simcom300-

- i. Wireless data transfer
- ii. Energy industry monitoring
- iii. Traffic system monitoring
- iv. SMS based Remote Control & Alerts
- v. Security Applications
- vi. Intelligent house monitoring
- vii. GPRS Mode Remote Data Logging
- viii. Sensor Monitoring
- ix. Agricultural feeding monitoring
- x. Parking monitoring
- xi. Telecom monitors
- xii. Meter reading
- xiii. Dial back-up for broadband connections
- xiv. Residential lighting controls
- xv. Messages/alerts
- xvi. Personnel management

Features of GSM modem

- i. This GSM modem is a highly flexible plug and play quad band GSM modem
- ii. Reset button, power can be started automatically or manually started.
- iii. For direct and easy integration to RS232.
- iv. Supports features like Voice, Data/Fax, SMS, GPRS and integrated TCP/IP stack.
- v. Control via AT commands (GSM 07.07, 07.05 and enhanced AT commands)
- vi. Use AC – DC Power Adaptor with following ratings · DC Voltage : 12V /1A
- vii. Current Consumption in normal operation 250mA, can rise up to 1Amp while transmission.

Interfaces

- i. RS-232 through D-TYPE 9 pin connector,
- ii. Serial port baud rate adjustable 1200 to 115200 bps (9600 default)
- iii. SIM card holder
- iv. Power supply through DC socket
- v. SMA antenna connector and Wire Antenna (optional)
- vi. LED status of GSM / GPRS module

Package Contents

- i. GSM Modem With Rs232
- ii. Antenna Single stand Wire Antenna – SMA Connector and Stud Antenna – 150/- extra

- LCD

LCD is used in a project to visualize the output of the application. We have used 16x2 LCD which indicates 16 columns and 2 rows. So, we can write 16 characters in each line. So, total 32 characters we can display on 16x2 LCD. LCD can also be used in a project to check the output of different modules interfaced with the microcontroller. Thus LCD plays a vital role

in a project to see the output and to debug the system module wise in case of system failure in order to rectify the problem.

SOFTWARE FLOWCHART

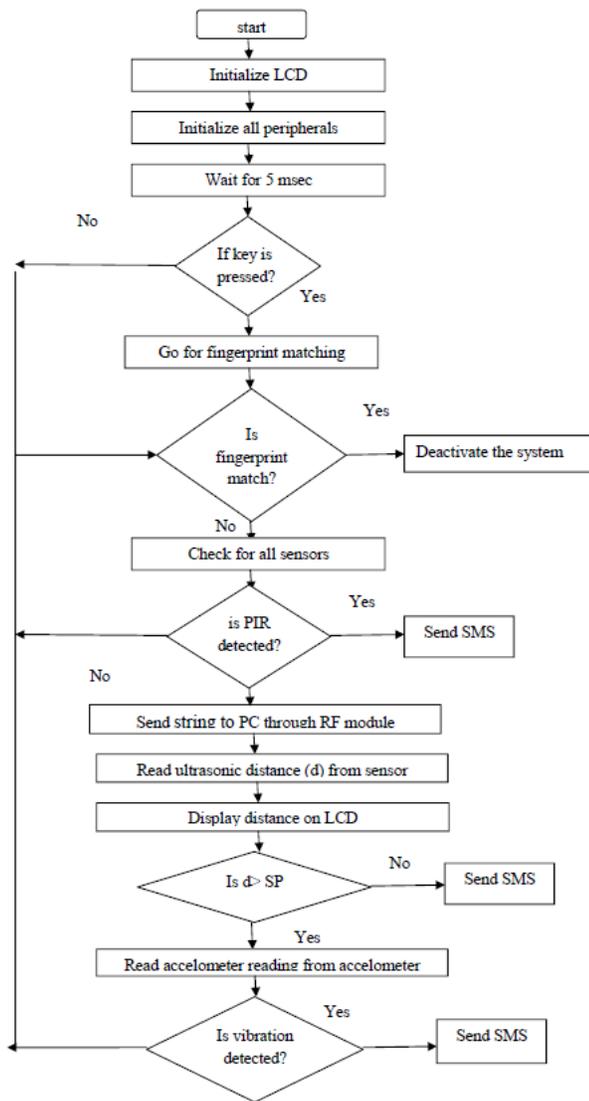


Figure 6. SOFTWARE FLOWCHART

ADVANTAGES AND APPLICATIONS

ADVANTAGES

- i. Low cost.
- ii. Low power requirement.
- iii. Good response.

APPLICATIONS

It can be used anywhere like in home, shop,, mall bank and at any important places.

CONCLUSION

The proposed approach uses the technique which combines the sensors along with fingerprint module and the concept of wireless communication. Fingerprint provides a solution for protecting the privacy of the user; since the user's true biometric feature is never changed in the whole life. Fingerprint is used for the better security and accuracy. In the privacy and security domains, the proposed method fulfils all requirements as to reject a forged person. Also if the unauthorized person tries to enter the sensitive area through another way like by breaking window or door the another sensors will activate the surveillance system and the alerting message can be send to the predefined number through GSM module. From the results obtained it is clear that the proposed approach provides very high accuracy. Thus the approach is very much secured. This approach can be enhanced to higher level in order to further improve the security. This common wireless security system can be extended in future by using several different types of required database that will be very hard to break by the attackers , by using another advanced sensors and thus it can provide better security.

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