

ARM Microcontroller Based Safety and Surveillance System



Jayendra Kumar, S. V. S. Gowtham Reddy, P. N. V. Shiva Krishna,
and G. Anjan Kumar

Abstract Nowadays, the entire world is getting into automation of devices which has eased the life of people in many ways. Moving further into the world of automation and building up an environment which will help the people in many ways such as controlling appliances providing security and making home free from thefts and fire accidents has been discussed in this paper. Here, a camera has been used for the identification of the person and a gas sensor which senses the gas leakages if any in the home and alerts the owner of the house regarding this. A temperature detecting sensor has been used which detects any abnormal change in temperature and alerts the user. ARM LPC2148 microcontroller is used here for controlling the sensor, and it also sends an alert message to user. For connectivity between the user and system, GSM module has been used in this process. PIR sensor has also been used to detect any intrusion and LDR sensor for detecting any thefts.

Keywords ARM microcontroller · GSM module · PIR sensor · Temperature sensor · LDR sensor

J. Kumar · S. V. S. Gowtham Reddy (✉) · P. N. V. Shiva Krishna · G. Anjan Kumar
Department of ECE, NIT Jamshedpur, Jamshedpur, Jharkhand 831014, India
e-mail: gowthamsvsr@gmail.com

J. Kumar
e-mail: jkumar.ece@nitjsr.ac.in

P. N. V. Shiva Krishna
e-mail: pnvshivakrishna@gmail.com

G. Anjan Kumar
e-mail: anjan4136@gmail.com

1 Introduction

The main aim of this system is to make home a safer place away from fire accidents and thefts. Security is one of most concerned aspects of everyone. This system enables the user to identify any unwanted intrusion that occurs at home or any fire accident that may arise due to short circuit or gas leakage. The mishap can be identified, and it is reported to the user within minimum time to the user so that he can take necessary measures to avoid any major circumstances. These days we have developed much advancement in technology on IOT [1–3] platform through which we can control any of the appliances be it at home, office or industries with the help of our smart devices like phones and laptops even from large distances. This system is fully automated with minimal manual instructions which make it fast, efficient and reliable. The components used in this system are widely available and are of low cost which makes it low cost effective and available to large part of people.

This system consists of ARM microcontroller [4, 5], GSM module [4, 6], PIR sensor, temperature sensor, gas detecting sensor, camera and relays [7]. ARM LPC2148 microcontroller is user friendly and can be easily interfaced and programmed with various output devices. GSM module is preferred over technologies like Bluetooth [6] and Wi-Fi [1, 5] due to its long-range connectivity with better speeds and efficiency due to its widespread coverage. Long-range connectivity is not possible with Bluetooth and Wi-Fi.

Here, sensors are connected to microcontroller. GSM modem is connected to the microcontroller which acts as a bridge between the user and the system at home. Whenever any person tries to enter home, PIR sensor [8] senses it and camera captures his face and sends it to the user. Based on the reply from the user whether the person is known person or unknown, the system takes necessary actions. If the person is identified as unknown person, then the system raises the alarm and alerts the neighbours and it also sends message to police through GSM module. Thus, it also provides surveillance along with safety from any fire accidents. GSM system has high security infrastructure, which gives us maximum reliability where people cannot monitor information sent or received.

2 Literature Review

Kodali and Jain [1] designed a system which is used for home automation and intruder detection. If any human movement is sensed near the entrance of home, the system sends an alert message to user and also the user can raise the alarm to warn the intruder and prevent him. Here, author implemented home automation in the same system through which the user can control the appliances of the home like lights, fan and AC through his mobile. Here, they sent the alert messages to user through voice calls which can be replaced with SMS which can also include the picture of intruder captured through camera installed in home. Kumar and Kumar [2] designed a

system which is used to control theft by using Raspberry Pi integrating with webcam and motion sensor. Whenever any intrusion is detected or wrong pin is entered at door lock, the webcam takes the image of the person and sends it to the user and the user can take necessary actions. In other paper [3], they designed a low cost-effective system which saves large amount of data and power. The system remains idle when there is no motion, and it records only when there is an intrusion; thus, it saves more data and consumes less power which makes it efficient and better. When motion is detected, the captured video sensor data are stamped on image using image processing techniques on Python platform. Data stored in local storage device, after certain threshold, will be uploaded into the cloud along with data log created during processing stage.

Sunehra [4] used PIR sensor and IR sensor with ARM7 microcontroller to design a surveillance system to detect intrusion. They used GSM for connectivity between user and system. Keshamoni and Hemanth [5] used MQ-2 (gas sensor) and LM35 (temperature sensor) to detect any gas leakages in the surroundings. When any change is detected by one of the sensors, the siren is triggered and the user is warned. Vaidya and Vishwakarma [6] provided a comparative analysis of the technologies like GSM, Bluetooth and Wi-Fi. After ample research, they provided the comparative analysis of each technology, its advantages and disadvantages. Author concluded that GSM is preferable over other technologies like Wi-Fi and Bluetooth due to its long-range connectivity and widespread coverage which enables us to control the devices even when we are far away.

Recently, Gupta and Kumar [7] designed a system for the purpose of monitoring and irrigation of plants using sensors. The data about the temperature and humidity can be obtained from anywhere by using the Android mobile application as data is uploaded to cloud. To avoid the events such as burglary or intrusion, Sahoo [8] designed a system using PIR sensor to detect intruder and ESP8266 module to send data to remote server. Here, GSM module is used to send text alerts to user when an intrusion occurs.

3 Proposed System

The block diagram of our proposed safety and surveillance system is given in Fig. 1.

The sensors are connected to ARM LPC2148 microcontroller shown in Fig. 2. ARM LPC2148 is a 32-bit RISC microcontroller. It has two UART ports, and it works on a 5 V output DC supply. It also includes many features like I2C serial interfaces and two SPI serial interfaces along with pulse width modulation (PWM) unit, a real-time clock and can reach up to a speed of 60 MHz.

It has a vectored interrupt controller with configurable priorities and vector addresses.

PIR sensor used to detect intrusion is shown in Fig. 3. PIR sensor is used to detect intrusion by an unknown person. PIR sensor [9] senses the IR light radiating from objects, and it also senses the movement of people in its range, and whenever an

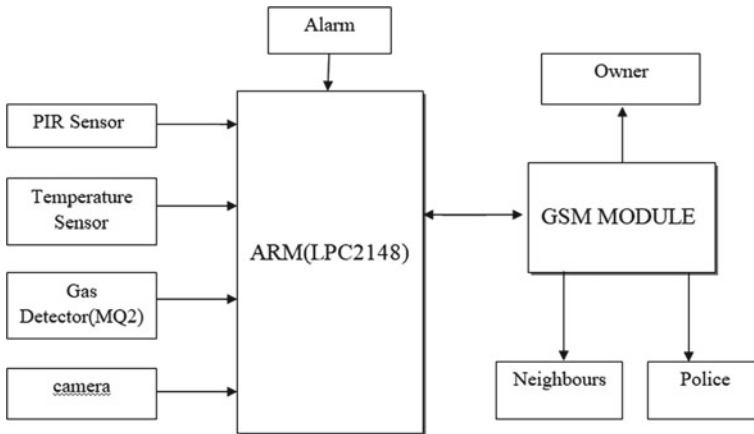


Fig. 1 Block diagram of ARM-based safety and surveillance system

Fig. 2 ARM LPC2148 microcontroller



intrusion occurs, it sends a signal to microcontroller which in turn sends an alert message to the user about the intrusion. Depending upon the amount of IR radiation that is emitted by body, it can differentiate between human and animal, so that it will not send an alert message when any small animal like cat enters the house.

Here, a camera is installed in the system which is used to take the picture of the intruder and send it to the user through microcontroller. If the intruder is a known person to the user, then by instructions, he tells the system that he is a known person and there is no harm. Then, the system which is initially given with pictures of user's family adds the picture of this person to the list of known persons. Due to this, if the

Fig. 3 PIR sensor for intrusion detection



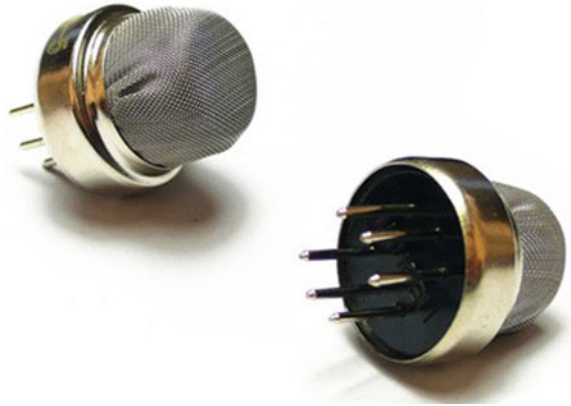
same person tries to enter the house afterwards, the system will not warn the user which is of much convenience.

To avoid fire accidents and gas leakages, temperature sensor is employed which is shown in Fig. 4 and gas detecting sensor in Fig. 5. Initially, threshold value of temperature is given to the system to which the system compares the recorded value. The temperature sensor senses the temperature timely and sends the value to controller. If the present value is higher than the threshold value, then it indicates an abnormal increase in temperature which may be due to fire accidents like short circuit. The smart home [10] system then immediately sends a warning message consisting of detected temperature to the user. The user will send a message through GSM [11]

Fig. 4 Temperature sensor



Fig. 5 MQ-2 gas detecting sensor



after which the neighbours are alerted through the alarm [12], and it will send a message also to fire department about the situation which may allow them to curb the fire accident within scope.

A MQ2 gas detecting sensor is installed in the kitchen. If at any instant gas leakage occurs, then the sensor sends signal to microcontroller which immediately sends an alert message to user about the gas leakage, and also, it alerts the neighbours about leakage.

GSM modem is used for connectivity between the user and microcontroller. GSM module is connected to microcontroller using an RS232 interface. RS232 voltage levels are at ± 12 V, whereas microcontroller input and output operate at 0–5 V; hence, RS232 [13] is not compatible to microcontroller. Here, MAX232 [14] which is shown in Fig. 6 is used to enable the communication between GSM module and microcontroller. MAX232 converts the RS232 level signals to TTL level signals. Hence, when any mishap occurs at house, the ARM microcontroller [15] then sends an immediate message through GSM module to the user using IOT [16–20]. The outgoing message contains information regarding mishap whether it is intrusion, fire accident or gas leakage. It waits for user's instruction to take necessary action. The GSM module used is shown in Fig. 7.

GSM module consists of SIM800A for connectivity. It is a quad-band GSM/GPRS module that works on frequencies GSM 850 MHz; EGSM 900 MHz, PCS 1900 MHz and DCS 1800 MHz. SIM800A can meet most of the space requirements in user's applications, such as M2M, smartphone and other mobile devices and supports one pulse width modulation (PWM) and pulse coded modulation (PCM). Our proposed architecture is shown in Fig. 9.

4 Proposed System Architecture

Our working procedure is depicted in Fig. 8. The PIR sensor continuously checks for the intruder when it is connected to the microcontroller. When the PIR sensor

Fig. 6 MAX232

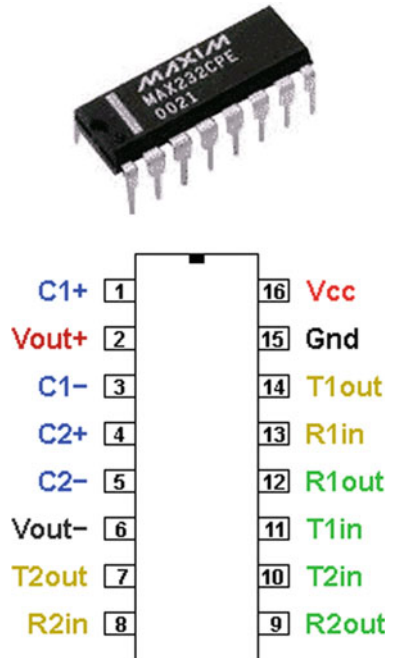
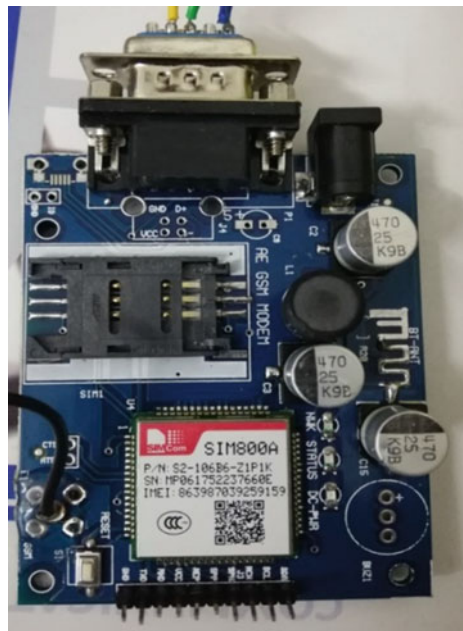


Fig. 7 GSM module consisting of SIM800a



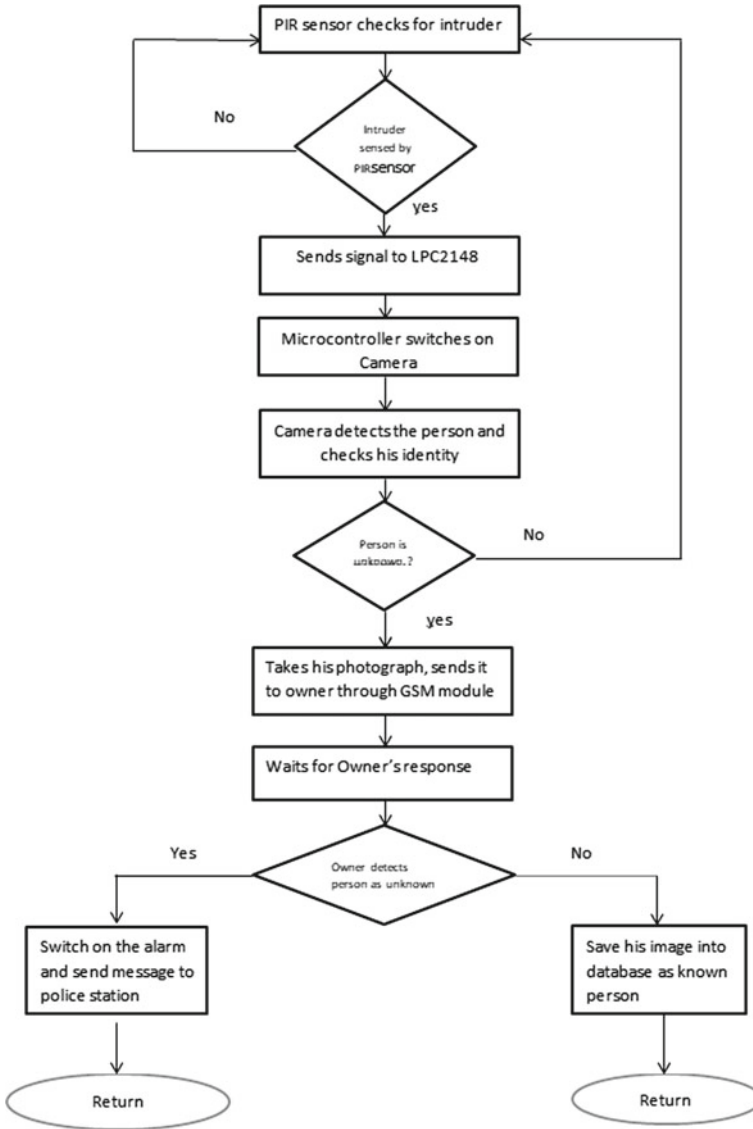


Fig. 8 Flowchart for detecting intrusion using PIR sensor and surveillance camera

detects any infrared radiation which is of any human beings (i.e. the threshold value of infrared radiation is assigned such that it is of humans), it sends a signal to ARM LPC2148 microcontroller which in turn on the camera. The camera then takes snap of the person and checks whether the person is actually an intruder or known person using data which is already assigned given to the microcontroller. If the person is an intruder, the microcontroller sends the image of the person using GSM module.

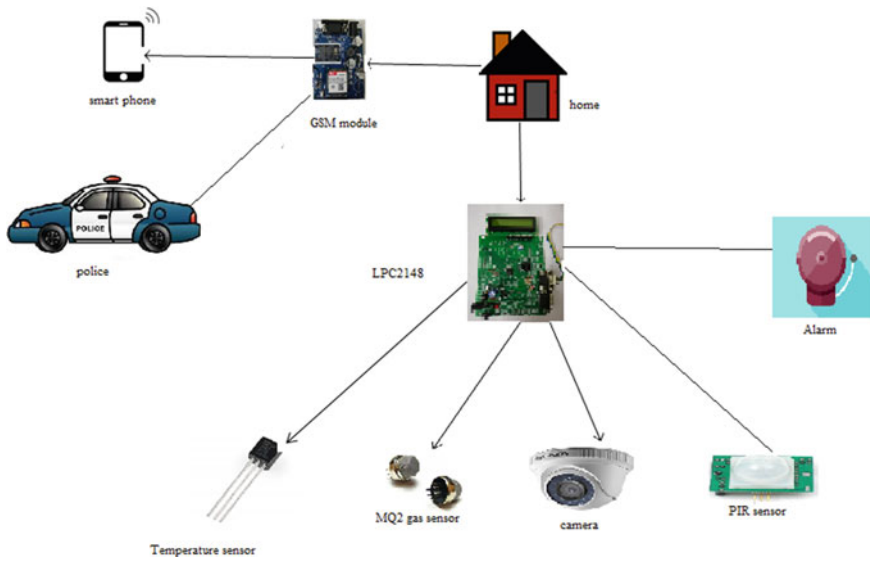


Fig. 9 Architecture of the proposed system

It waits for the owner’s instruction. If the owner recognizes the person, he sends a message to add the person’s image to database, and if the person is an intruder, the microcontroller then sends message to police and neighbours, and it also switches on buzzer alarm. The same conditions and procedure are followed for fire detection and gas leakage (Fig. 9).

5 Advantages

Compared to the existing models, this system provides more features which are as follows

- Provides more security.
- Includes safety and surveillance of home under same system.
- Contains minimal manual instructions making it more efficient and reliable.
- Can also be used for home automation of appliances.

6 Conclusion

We designed a cost-effective system based upon ARM LPC2148 microcontroller which can be used for safety of the home from fire accidents and gas leakages. It also provides theft control by informing the user whenever any intrusion occurs. The

system can differentiate between a known person and an unknown person which prevents sending an alert message when the person entered is known to the user. The fast and efficient connectivity of GSM module enables the system to send an immediate alert message to user even when he is far from home. With the help of cloud storage, we can store the known person's image in it and also store the video recorded by camera during surveillance.

With the advent of the latest technology like LTE, we can get greater speeds and better connectivity, which can be used in system for better efficiency. We can also use the system to control appliances like light, fan, AC and other devices making the system a fully home automated and security system.

References

1. Kodali RK, Jain V, Bose S, Boppana L (2016) IoT based smart security and home automation system. In: IEEE international conference on computing, communication and automation (ICCCA), Noida, India, 29–30 Apr 2016
2. Kumar J, Kumar S, Kumar A, Behera B (2019) Real-time monitoring security system integrated with Raspberry Pi and e-mail communication link. In: 9th international conference on cloud computing, data science & engineering confluence 2019, Noida, India, 10–11 Jan 2019
3. Kumar J, Ramesh PR (2018) Low cost energy efficient smart security system with information stamping for IOT networks. In: 2018 3rd international conference on internet of things: smart innovation and usages (IoT-SIU), Bhimtal, India, 23–24 Feb 2018
4. Sunehra D, Bano A (2014) An intelligent surveillance with cloud storage for home security. In: 11th annual IEEE India conference (INDICON-2014) on emerging trends and innovations in technology, Pune, India, 11–13 Dec 2014
5. Keshamoni K, Hemanth S (2017) Smart gas level monitoring, booking & gas leakage detector over IoT. In: IEEE 7th international advance computing conference (IACC), Hyderabad, India, 5–7 Jan 2017
6. Vaidya VD, Vishwakarma P (2018) A comparative analysis on smart home system to control, monitor and secure home, based on technologies like GSM, IOT, Bluetooth and PIC microcontroller with Zigbee modulation. In: IEEE international conference on smart city and emerging technology (ICSCET), Mumbai, India, 5 Jan 2018
7. Gupta N, Kumari A, Kumari S, Kumar J (2019) Automatic plant watering and monitoring system using Nodemcu. In: 9th international conference on cloud computing, data science & engineering confluence 2019, Noida, India, 10–11 Jan 2019
8. Sahoo KC, Pati UC (2017) IoT based intrusion detection system using PIR sensor. In: 2017 2nd IEEE international conference on recent trends in electronics, information & communication technology (RTEICT), Bangalore, India, 19–20 May 2017
9. Moghavvemi M, Seng LC (2004) Pyro electric infrared sensor for intruder detection. In: IEEE region 10 conference TENCON 2004, Chiang Mai, Thailand, 24 Nov 2004
10. D'souza M, Wilfred N, Pereira R, Rayen T, Telgote A (2016) Home automation using internet of things. In: IEEE 7th annual ubiquitous computing, electronics & mobile communication conference (UEMCON), New York, USA, 20–22 Oct 2016
11. Gu G, Peng G (2010) The survey of GSM wireless communication system. In: IEEE international conference on computer and information application, Tianjin, China, 3–5 Dec 2010
12. Mrinal M, Priyanka L, Saniya M, Poonam K, Gavali AB (2017) Smart home—automation and security system based on sensing mechanism. In: 2017 second international conference on electrical, computer and communication technologies (ICECCT), Coimbatore, India, 22–24 Feb 2017

13. Teymourzadeh R, Ahmed SA, Chan KKW, Hoong MK (2013) Smart GSM based home automation system. In: IEEE conference on systems, process & control (ICSPC2013), Kuala Lumpur, Malaysia, 13–15 Dec 2013
14. Loganthurai P, Shalini M, Vanmathi A, Veeralakshmi M, Vivitha V (2017) Smart energy meter billing using GSM with warning system. In: IEEE international conference on intelligent techniques in control, optimization and signal processing (INCOS), Srivilliputhur, India, 23–25 Mar 2017
15. Vidya KS, Manikanthan SV (2015) An android based secure access control using ARM and cloud computing. In: 2015 2nd international conference on electronics and communication systems (ICECS), Coimbatore, India, 26–27 Feb 2015
16. Gupta KK, Shukla S (2016) Internet of Things: security challenges for next generation networks. In: IEEE international conference on innovation and challenges in cyber security (ICICCS-INBUSH), Noida, India, 3–5 Feb 2016
17. Vikram N, Harish KS, Nihaal MS, Raksha U, Kumar SAA (2017) A low cost home automation system using Wi-Fi based wireless sensor network incorporating Internet of Things (IoT). In: 2017 IEEE 7th international advance computing conference (IACC), Hyderabad, India, 5–7 Jan 2017
18. Lee HR, Lin CH, Kim WJ (2016) Development of an IoT-based visitor detection system. In: International SoC design conference (ISOCC), Jeju, South Korea, 23–26 Oct 2016
19. Beltran V, Martinez JA, Skarmeta A, Julia PM (2016) An ARM-compliant IoT platform: security by design for the smart home. In: 2016 IEEE 5th global conference on consumer electronics, Kyoto, Japan, 11–14 Oct 2016
20. Mandula K, Parupalli R, Murty CHAS, Magesh E, Lunagariya R (2015) Mobile based home automation using Internet of Things (IoT). In: 2015 international conference on control, instrumentation, communication and computational technologies (ICCICCT), Kumaracoil, India, 18–19 Dec 2015