Design and Implementation of Raspberry Pi Based Remote Home Security and Appliance Control System

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Abstract—The security is always a concern when a person leaves his house. In this paper we design and implement a home surveillance system. The system is designed to detect an intruder entered in the house and fire caused due to some accident. The system uses IR (Infrared) obstacle sensor and fire sensor to detect the suspicious activity. The system uses ZigBee technology to make it wireless inside the home. On detecting the suspicious activity, it quickly alerts the user by sending an SMS using the GSM module. The user can check the status of sensors on the web page. The web page also allows the user to monitor the system visually by showing the recent photos taken by the camera after every 30 minutes and also the user can start the live video streaming on a button click. The web page also allows user to control the household appliances from a remote place.

Key words: Home Security, Raspberry Pi, Sensors, Arduino, Zigbee, GSM (Global System For Mobile Communications), SMS (Short Message Service), GPRS (General Packet Radio Service)

I. INTRODUCTION

Security is the main concern for everyone. Everyone wants to be secure inside their houses. Everybody wants them to keep safe from incidents like robbery in their houses or accidents caused due to gas leakage or due to fire. We frequently use surveillance system in homes, offices or factories [1]: Due to increase in the use of mobile devices, controlling the home appliances and monitoring home from a remote place has become quite popular. The idea of monitoring and controlling of home appliances from a remote place is changing day by day with the use of latest technologies. Many types of remote monitoring and controlling systems are already available.

Bluetooth based systems are discussed in [2][3]. Bluetooth eliminates the usage cost of the network to a great extent, but it has a very limited range of operation which is in meters. So it is not possible to remotely monitor and control appliances by using this technology. Another problem of using this technology is interference.

Some of the existing systems use text messages (SMS) for sending the control signals to the home [4][5]. The main advantage of using SMS based system is even if the network is busy, continuous effort of delivery is made unless the network is reachable. After the SMS is delivered, an acknowledgement is sent to the sender of the SMS. GSM provides great network coverage and reduces the implementation cost by eliminating the need of cables and wires; but it does not provide real time monitoring when the data in the form of video is considered. Short messages can be used to send controlling signals like on and off. But this system is not cost-effective since SMS cost a lot.

Remote monitoring systems can also be accessed using telephone that has a support of dual tone multiple frequencies (DTMF) [6]. In this technology internet is not required; all communication occurs over a fixed phone. But there is no graphical user interface available to users, they have to remember access codes and memorize which button is to be pressed in order to control the device. Moreover it is not very efficient technology since it takes many seconds to send commands.

The proposed system provides web interface for monitoring and controlling household appliances. This system allows the user to control his/her home from a distant place via the internet. According to the survey on controlling methodology it was identified that controlling the devices through web interface is the best means of controlling. ZigBee technology is used to address the need for a cost-effective system that supports low data-rates, low power-consumption, security and reliability [7]. Real time data acquisition and high data rate can be achieved by using GPRS technology.

II. METHODOLOGY

A. System Overview:

Fig. 1: System Architecture

Fig. 2: Raspberry Pi Board
The architecture of the proposed system is shown in Fig 1. The system composed of IR obstacle sensor and the fire sensor which will sense the data and send it to the web server wirelessly. Here Raspberry Pi is used as a web server which is shown in Fig. 2. Raspberry Pi is a Linux based single board computer which has a Broadcom BCM2835 system on a chip (SOC).

GSM module is interfaced with the Raspberry Pi which will send an alert SMS to the user when the suspicious activity is detected. The whole system is accessed by a web page. The web page is designed using HTML and PHP. The web page allows the user to monitor and control the home appliances from a remote place. It also allows the user to see the recent photographs and live video streaming when the intruder is entered inside the home. Users interact with the system using standard web browsers. The pictorial view of overall system is shown in Fig. 3.

The system has following features:

1) User friendly interface: The system is user friendly. Anyone with little knowledge of internet can use to control the home appliances and can also ensure safety of his/her house. The web page asks for the username and password to ensure that it is in the hand of proper user.
2) User alert: Whenever the system detects the unexpected event occurring in the house then it quickly sends an alert SMS to the user.
3) Wide area coverage: Now a day’s almost every corner of the world is covered by GSM network. So the users can connect to the internet and interact with system even from a very remote place far from urban areas.

B. Interfacing:

1) Camera Interfacing:

Fig. 4 shows Raspberry pi camera interfaced to the Raspberry Pi. The Raspberry Pi has a Camera Serial Interface (CSI) connector, which allows the connection of Raspberry Pi camera to the main Broadcom BCM2835 SOC. The command line tools for using the camera module are

1) raspistill – to capture the still photographs.
2) raspivid– to capture the video of specified time duration.
3) raspipyuv – to capture the still photographs and generate raw unprocessed image files

2) Raspberry Pi and Zigbee Module Interfacing:

Fig. 5 shows connection between Raspberry Pi and ZigBee module (configured as coordinator) through UART. Here Digi’s XBee series 2 is used as ZigBee module. We have to turn off UART functioning as a serial console for this connection. By default the Raspberry Pi’s serial port is configured to be used for serial console input/output. To be able to use the serial port to connect and talk to other devices like XBee, the serial port console login needs to be disabled. Needless to say we will need some other way to login to Raspberry Pi and for that using an SSH connection.

C. System Operation:

The operation of the system is shown in Fig. 6. The user has to activate the system while leaving the house. When the user comes to the house then he/she has to deactivate the system so that they won’t send any notification to the user while he/she is inside the house.
The sensors placed inside our home can be used to detect an unexpected event happening in the house. The system is designed to detect burglary, fire caused by some accident, and after detecting suspicious activity, it quickly alerts the user about it. Each sensor is connected to one Arduino Uno board which will act as one sensor node.

1) The sensor data after processing by Arduino is sent to the Raspberry Pi wirelessly using the ZigBee module. Each node is having one ZigBee module (configured as router) to send the data to the web server. The ZigBee coordinator is interfaced with the web server which collects the sensor data.

2) The sensor data is stored in the database which can be fetched and displayed on the web page. Python script is written which reads the sensor data from the serial port and stores it to the database. Here MySQL database is used to store the data.

3) The web page of the proposed system is shown in Fig. 10. The web page is designed using PHP and HTML language. PHP is a server-side scripting language, and it is used to make dynamic and interactive web pages. It is a widely-used, free, and more efficient. Auto-refresh PHP script allows the web page to refresh after every 1 minute so that we can see the data changing dynamically. The system uses an authentication page which after login redirects us to the main web page. The flowchart of the process is shown in Fig. 7.

III. RESULTS

The system alerts the user about the suspicious activity. GSM module serves this job. It sends an alert SMS to the user upon suspicious activity detection which is shown in Fig. 7.
After detection, the sensor data is sent to the web server wirelessly using ZigBee module. Data get stored in the MySQL database as shown in Fig. 8. The database contains separate tables for storing the sensor data. The status of the sensor is '1' after detection.

The user can monitor his/her home by accessing a web page which is designed in HTML and PHP shown in Fig. 8. The web page refreshes after every minute so that user can see dynamic change in data.

The web page also allows the user to monitor his/her house visually by using Raspberry Pi camera. The camera captures the image every 30 minutes and the web page fetches the recently captured image and displays it. The web page also has the feasibility to start live video streaming on button click. Fig. 10 shows recent image at the left and video streaming at the right side.

IV. CONCLUSION

Raspberry Pi board is made ready to be used as communication terminal. Raspberry pi can be accessed by multiple clients remotely from anywhere. We can see the sensors data collected on Raspberry Pi database. It consumes very less power as compared to other traditional gateway or computer. Raspberry Pi minicom serial terminal is correctly receiving the sensor data sent by the sensor nodes. The data can be fetched and displayed on the web page. The user is able to visually monitor his/her house. This paper presents easy way to control the appliances and get notified about the suspicious activity.

REFERENCES