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ANDROID BASED HOME AUTOMATION AND VISION SURVEILLANCE USING RASPBERRY PI

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ABSTRACT

In recent years, the home environment has seen a rapid development of home automation and various security measures. This technology offers new and exciting opportunities to increase the connectivity of devices within the home for the purpose of home automation and also it provides security through visual surveillance. Mobile devices are ideal in providing a user interface in a home automation system and also a monitor for surveillance, due to their portability and their wide range of capabilities. They can communicate with a home automation network through an Internet gateway, but cannot directly communicate with devices in the network, as these devices usually implement low power communication protocols, such as ZigBee, WiFi etc. In this project we aims at controlling Home appliances and visually monitor the home, via Android device using Internet as communication protocol (provides worldwide accessibility), Raspberry Pi as server system and Infra-red camera for surveillance. In our system user will be notified through android device when motion is detected in surveillance area. We create a user friendly interface for the android device that allows the user to communicate with the Raspberry Pi server. The server will be interfaced with a relay circuit board that controls the appliances running in Home and it is also connected to an Infra-red Camera to provide surveillance. By this we offers a scalable and cost effective Home automation and surveillance system.

KEYWORDS: House Automation, Surveillance, Worldwide Accessibility, Raspberry Pi, Android, etc

INTRODUCTION

In this project we focus on two main aspects, Home automation and visual surveillance. The home automation refers to domestic environment that improves the quality of the resident's life by facilitating a flexible, comfortable, healthy, and safe environment. Internet based home automation systems become the most popular home automation system in international markets;. The remote controlling and monitoring of a house using internet requires computer, which is large in size and heavy to carry around. In our system we use low cost ARM processor as a substitute for huge computer. The most available home automation systems use different wireless communication standard to exchange data and signaling between their components, like Bluetooth, Zigbee, Wi-Fi, etc which are of low communication range. But Using Internet provides us a worldwide range of communication.

In Home automation system there are collections of interconnected devices for controlling various functions within a house. Android devices are cheap substitute in controlling this automation system. Android device provide a better user interface for controlling this system. We developed an android application that effectively act as control panel for controlling the loads, monitor the environment and provide a image frames of the surveillance area.

The current existing home security system for anti-theft and fire system includes infrared rays for input process. Even though these types of security system are comprehensive yet there are still some defects such as the range of infrared based home security system is 4 to 5 meters. The consumers are to keep co-operative relationship with the security service provider and so they have to expense much for to the provider for good service quality. There remain no record how and who has broken the security system and entered the house.

In this project we connect an infrared camera to the Raspberry Pi embedded board, to provide visual surveillance. Raspberry Pi process the frames captured by the camera and check for motion objects in it. If motion is detected it pop up a notification to android device through internet and also record the frames in its local storage. After notification user could able to see the recorded frames as a video. Here we use motion detection algorithm to detect the motion inside the surveillance area. Though some advanced system provides face detection capabilities there occurs some complications when the intruders wears a mask. Hence the user is left with the decision to take the necessary action, once the intrusion is detected and notified through his android device. The user interface of the android application provides the facility to turn ON and OFF the surveillance mode, and provided the load control is possible anytime. The android application communicates with the Raspberry Pi server for each user command. Similarly Pi communicate with the android application to notify the user about the intrusion.

RELATED WORKS

Enabling Mobile Devices for Home Automation Using Zig Bee

Home automation systems are collections of interconnected devices for controlling various functions within a house, such as light control, heating, air conditioning, etc. Mobile devices are ideal in providing a user interface in a home automation system, due to their portability and their wide range of capabilities. They can communicate with a home automation network through an Internet gateway, but cannot directly communicate with devices in the network, as these devices usually implement low power communication protocols, such as ZigBee.

There are several methods to equip an Android device with a dongle capable of ZigBee communication. The use of multiple communication channels, such as the TCP channel, that uses WiFi to connect to a gateway, and the USB channel, that can connect to a device on the home automation network through an USB dongle. Modern mobile devices have embedded modules for several wireless communication technologies, such as WiFi, UMTS and Bluetooth. The home automation system consists of various home automation devices interconnected in a wireless sensor network, a gateway at the edge of the network and one or more client devices, that can be either smart phones, tablets, or laptops.
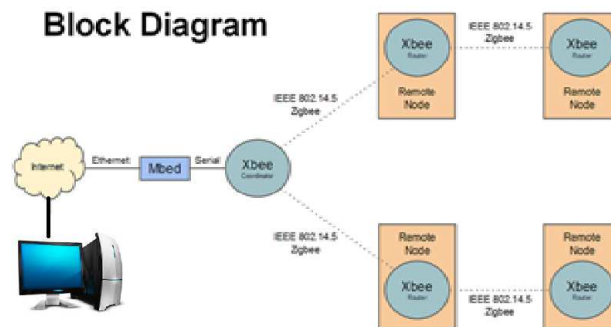

Figure 1: Design and Implementation of SMS Based

Home Automation System

This system presents design and prototype implementation of a basic home automation system based on SMS technology. The automation system consists of two main components; the GSM modem, which is the communication interface between the home automation system and the user. GSM modem uses SMS technology to exchange data, and signalling between users and home automation system. The second module is the microcontroller, which is the core of the home automation system, and acts as the bridge between the GSM network (the user) and sensors and actuators of home automation system. Sensors and actuators are directly connected to hardware micro controller through appropriate interface. System supports a wide range of home automation devices; power management components, security, multimedia applications, and telecommunication devices. System security based on user authentication of each SMS being exchange, as each SMS contains user name and password (beside comments). User can easily configure home automation system setting through RS232 protocol using a user friendly interface.

Figure 2: Vision System for Counting People

An intelligent security system that provides home security using visual surveillance is developed and explored in this paper. This will be very much useful in home and company automation. The main processing unit is a cortex ARM processor with Linux operating system and the board we are using is Beagle Bone Black (BBB). Surveillance system is achieved using Open CV(open source computer vision) and the communication system is designed by using GSM(Global System for Mobile Communication) Module. Total number of people in a room is counted by using the Open CV. The user while leaving the premises can give voice command to make the system active. The system continues automatic surveillance when the user left the house or office. It can be modified to turn on automatic surveillance at a specific time of the day. If the user left the premises and the system detects the presence of a human being in there then an SMS will be sent to the Cell phone of the user and the alarm will be turned on. After turning on the alarm the system will start recording video on the SD card so the user can inspect later. The system can also count the number of people in the room by using image processing algorithm and will automatically turns off all the load in the room when no one is present. This will also help to reduce the unnecessary wastage of power.

Java Based Home Automation System

This paper presents the design and implementation of a Java-based automation system that can monitor and control home appliances via the World Wide Web. The design is based on a stasnd alone embedded system board integrated into a PC-based server at home. The home appliances are connected to the input/output ports of the embedded

system board and their status are passed to the server. The monitoring and control software engine is based on the combination of Java Server Pages, JavaBeans, and Interactive C. The home appliances can be monitored and controlled locally via the embedded system board, or remotely through a web browser from anywhere in the world provided that an Internet access is available. Appliances at home are connected to an embedded system board (E-board). The control code on the E-board operates the appliances and communicates with Java-based code that resides at the server at home. The user can interact with the home automation system from anywhere at any time.

PROPOSED SYSTEM

Every user who is experienced in the existing system may think of a system that may add more flexibility and run with some common applications such as android. The proposed system is designed in such a way to avoid the limitations of the existing system. The proposed system supports more flexibility, comfort ability and security.

The proposed home automation system is working with very popular android phones. It is having mainly three components; the android enabled user device, an internet connection with good bandwidth, and a raspberry pi board. Here the users have provision to control the home appliances through android enabled device. This will improve the system popularity since there is no need for a wired connection or any other additional modules. The instructions from the user will be transmitted through the internet. The raspberry pi board is configured according to the automation and surveillance system and it will enable the relay circuit as per user request. The relay circuit can control the home appliances. Video recorded by the system provide more reliable surveillance to the user and the user can also check the current status of the appliances. OpenCV used for motion detection provides more accuracy.

The main objectives of the proposed system is to design and to implement a cheap and open source home automation system that is capable of controlling and automating most of the house appliances through an android device.

Advantages of Proposed System

The new system must provide the following features

- It allows more flexibility through android

- It provides more accuracy of intruction.

- It provides security and authentication.

- Additional vendors can be easily added.

WORKING SYSTEM

Our system consist of following major modules

- Hardware and Automation module

- Vision surveillance module

- Android application module3.1 Notification and Mode Status 3.2 Remote Automation
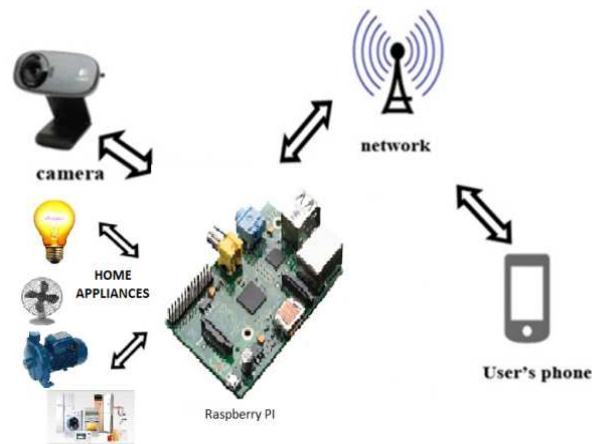
Architecture Diagram

Figure 3

Hardware and Automation Module

The major Hardware components used in this system are Raspberry Pi, relay circuit, infrared camera ,android devices etc.

The Raspberry Pi is a low cost single-board computer which is controlled by a modified version of Debian Linux optimized for the ARM architecture. The core of the home automation system is this minicomputer. Here we are using model B ,700 MHz ARM processor with 512 MB RAM.
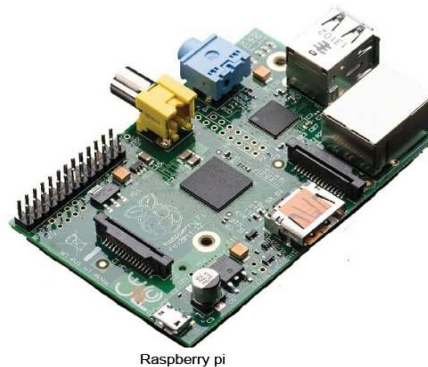

Figure 4

The raspberry pi runs a server program such Apache Tomcat that serves the android user application and the appliances. Relay circuit interfaces the electrical appliances and Raspberry Pi's GPIO pins. When the Pi sends the signal, the relay controls the appliances according to it. Camera module is connected to Raspberry Pi for surveillance. Pi act as Server both automation and surveillance. Pi is capable of communicating through Internet for controlling appliance and also process the frames captured by the camera to detect the motion object (Intruder).
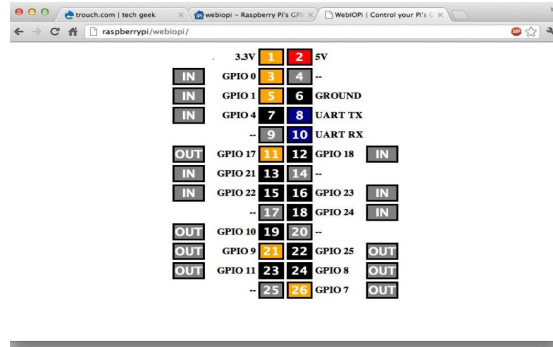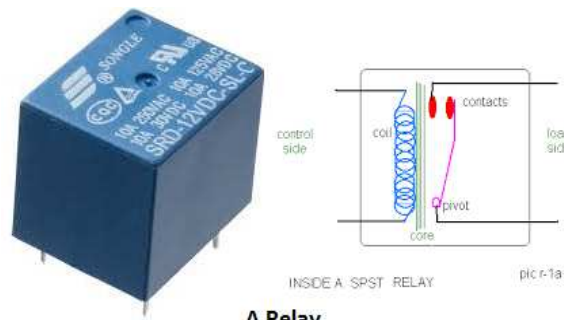
Figure 5

A Relay

Figure 6

Vision Surveillance Module

Vision Surveillance is implemented through Open Source Computer Vision Library (OpenCV) using Motion Detection Algorithm. Using this algorithm, Pi process the frames captured by the Camera. Here motiondetection is determined by using OpenCV with background subtraction method.

The camera captures the frames and performs motion detection algorithm. In this method the frames captured through the camera are compared with one another to perform background subtraction. Say, a camera captures frame one and two. Initially it coverts these two frames into grey scale and then difference between these two frames are calculated . This difference is stored in buffer. Now the threshold is performed to neglect minute pixel changes due to lightning conditions and then image is smoothened to remove lightning noise. The smoothened image is down sampled ,dilated and then up sampled to remove the noise and isolate individual segmentations and joining the separate elements of image. The result is contoured to retrieve the boundary of the motion detected in the difference of the two frames. Now it is necessary to check the contour area , whether it is in the permissible limit. If not, notify the user.
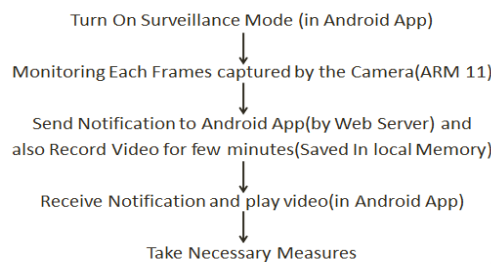
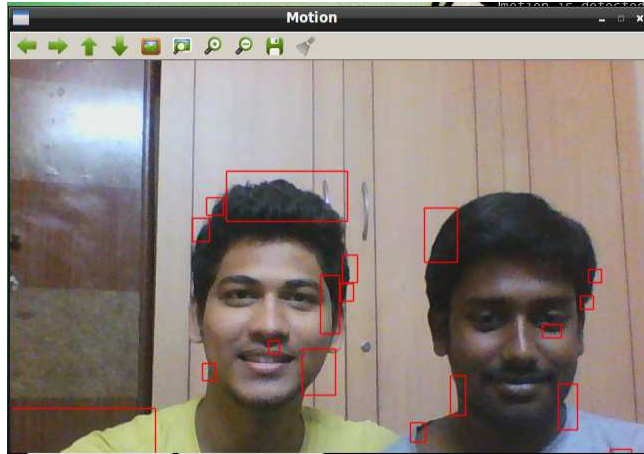**Work Flow of Surveillance Module**

Figure 7

Figure 8

Android Application Module

It contain two Interfaces:

- Notification and Mode Status

- Remote Automation module

- Notification and Mode Status:

When the user switches the surveillance mode in the user interface, the system starts to monitor the surveillance area. If any intrusion is detected, the user is notified through the HTTP server and android application with a sound alert. The user can also view the recorded video of the intruder in the UI screen and then can take the necessary action such as turning on the alarm etc.
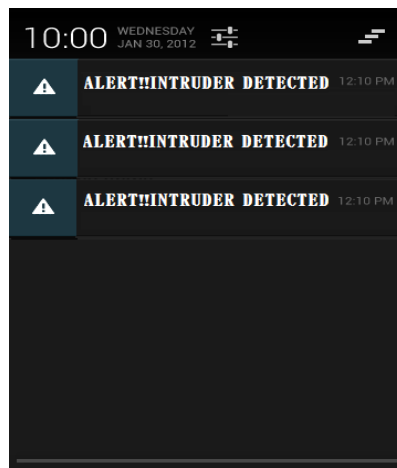

Figure 9

Remote Automation Module

In this interface the user is provided with screen containing vairous buttons with description to control each appliance. the below diagram show a model for the automation UI screen. It also describes the current status of the appliance.

Figure 11

FURTHER APPLICATIONS

- Automated fire exit systems can be build.

- Temperature and pressure monitor.

- LPG Gas leakage sensing and control.

- Water leakage sensing.

- Water level indication.

- Garage door monitor.

- Magnetic door open system.
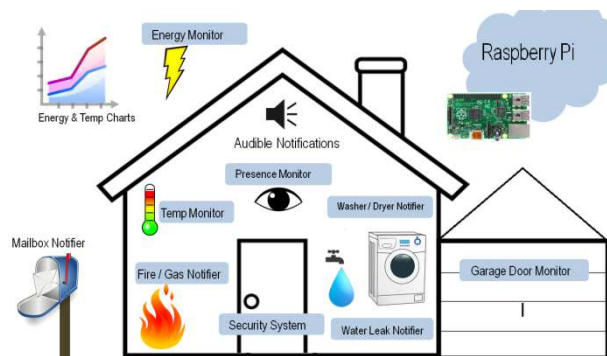
- Electricity usage monitor.

Figure 12

CONCLUSIONS

Thus this system is more flexible and provides attractive user interface compared to other home automation and security systems. In this system we integrate an android devices for home automation and surveillance. A novel architecture for a home automation system is proposed using the relatively new communication technologies. The system can be used in several places like banks, hospitals, labs and other sophisticated automated systems, which dramatically reduce the hazard of unauthorized entry. Evidence can be given to the security department if any robbery issue occurs.. We

hide the complexity of the notions involved in the home automation system by including them into a simple, cheap, flexible, but with powerful and comprehensive set of related concepts. This simplification is needed to fit as much of the functionality on the limited space offered by an android mobile device's display.

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