

Android Based Home Automation Using Raspberry Pi

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Abstract - In recent years, the home environment has seen a rapid introduction of network enabled digital technology. This technology offers new and exciting opportunities to increase the connectivity of devices within the home for the purpose of home automation. 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, WiFi etc. In this project we aim at controlling Home appliances via Android device using Wifi as communication protocol and Raspberry Pi as server system. 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. The communication with server allows the user to select the appropriate device. The server communicates with the corresponding relay. By this we offer a scalable and cost effective Home automation system.

Keywords – Home Automation.

1. Introduction

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. The most available home automation systems use different wireless communication standard to exchange data and signaling between their components, like Bluetooth, Zigbee, Wi-Fi, and finally the Global System for Mobile Communication (GSM). Wireless based home automation systems decrease installation cost and effort, and enhance system flexibility and scalability.

In Home automation systems there are collections of interconnected devices for controlling various functions

within a house. Mobile devices are ideal in providing a user interface in a home automation system, due to their portability and their wide range of capabilities. Within the house, the user might not want to go to a central control panel, or not even to the laptop, but use the phone that is usually placed in closer proximity to the user. When far from the house, the user might want to check its current status or even schedule actions for his return.

In concept of android based home automation system we can provide end users with simple secure and easily configurable home automation system. Also the concept can overcome the barriers facing home automation systems and will enable a home technology ecosystem that allows people to easily adopt the subset of home automation technology that appeals to their household. Home Automation is becoming an inevitable thing in our fast developing environment and current life style. New trends in lifestyle have enhanced the installation of automated home appliances in many places. Home automation not only refers to the automation of appliances in a house but also the automation of things that we use in our daily life such as cars, telephones etc. Automation of appliances was firstly introduced in offices for ease of use and also for reduction in time and cost consumption. Nowadays, home automation systems are available in a number of varieties. A few have been discussed here.

- Java-Based Home Automation System.
- Home Automation using GSM.
- Zigbee based Home automation.
- SMS based Home automation

Even if many varieties of home automation systems are available, current system has got a number of limitations. Currently home automation systems are implemented with a large amount of hardware. The installation and maintenance of the current system is a difficult task. It also imposes a huge installation cost on the user or consumer. Current home automation systems

are inefficient in security. They are also very poor in bandwidth utilization. They may either leave a large amount of bandwidth or it will be very less. In case of Zigbee the bandwidth is too low and in case of GSM it is too high. The java based home automation is very poor in security as the uses web pages to access and control the appliances. SMS based and GSM based home automation is costly for the consumer as it becomes expensive to communicate via SMS. The varieties of home automation system improves the quality of the resident's life by facilitating a flexible, comfortable, healthysafe environment.

2. Related Works

2.1 Home Automation Using GSM

This system presents a novel, stand alone, low-cost and flexible GSM- ZigBee based home automation system. The entire system depends on a 8 bit microcontroller named PIC (Peripheral Interface Controller) in this work. The Database equipment built around this Microcontroller and a GSM controller facilitate the heart of the system. This device is connected to a ZigBee Transceiver and it communicates with each and every node present inside our home. The GSM Controller facilitate for the data follow between user and microcontroller. The GSM Controller uses mobile phone technology to communicate. From the mobile phone, command can be send via SMS to the Controller, which in turn interprets the command and then activates the required 'switch' to control the electrical item. As long as there is GSM mobile phone signal coverage, it is possible to control all electrical items from anywhere in the world. The system is easy to operate, and is secure in that only pre-determined mobile numbers can operate the GSM Controller. The installation of the GSM Controller is relatively simple and can be adapted for any existing home system. Control of lights and geyser are done via the electrical distribution board (circuit breakers). The block diagram of system is as follows:

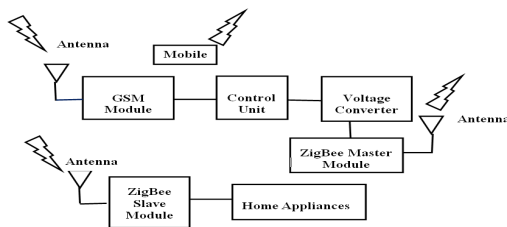


Figure 1

2.2 Enabling mobile devices for home automation using ZigBee

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.[2]

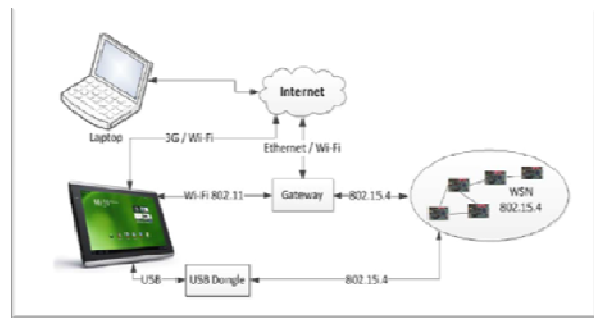


Fig 2:Home automation using Zigbee

2.3 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.

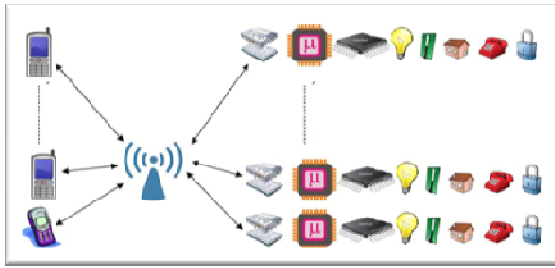


Fig 2.3 SMS Based Home Automation System

2.4 Bluetooth Communication using a Touch Screen Interface with the Raspberry Pi

This paper brings a low cost stand-alone device which transmits data using the Raspberry Pi with Bluetooth and has a resistive touch screen display providing a user interface. 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 display contains a graphical user interface which provides various fields for data entry via an onscreen keyboard. The display is connected to the Raspberry pi via HDMI.

Background fields for displaying and entering the data has been implemented using html. Button press animations and buttons for navigating between different pages of the GUI have been implemented using JavaScript. The user enters the data at the client end in the GUI. The acknowledgement received from the server end is displayed in the GUI. If the data received at the server end matches with the sent data, the values are displayed. Cyclic Redundancy Check for achieving data integrity during the transmission[3].

2.5 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 stand 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.

3. 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, a wifi router having a good scalable range, 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, internet etc. The instructions from the user will be transmitted through the wifi network. The raspberry pi board is configured according to the home system and it will enable the relay circuit as per user request. The relay circuit can control the home appliances also. We can add appliances to the system also can add additional security features.

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 device.
- It allows a good range of scalability.
- It provides security and authentication.
- Additional vendors can be easily added.

4. System Architecture

4.1 Overview

Home appliance network (home automation) is required to be without new wiring and to be very easy installation. Field of home appliance network is still young, many initiatives and standardization efforts have already been made. the new kind of system brought android and raspberry-pi into home automation implementation. The proposed system architectures generally incorporate a raspberry-pi computer for the purposes of network management and provision of

remote access .rasberry-pi can be configured according to our home system.

The user will communicate to rasperry-pi through wifi network. The system is flexible and scalable, allowing additional home appliances designed by multiple vendors, to be securely and safely added to the home network with the minimum amount of effort. the wifi network should be having adequate strength also. we can use a wifi-modem for steeping a wifi. the user can have a nice android interface for using the system. The serial data coming from wifi unit is connected to rasperry-pi circuit. The core of the home automation system consists of rasperry-pi board. it can be viewed as a mini computer capable of doing many functions. The rasperry-pi board is configured for each home appliances .so according to user intervention the matched out will make high and the corresponding relay will switch on and device start function. The system is scalable and allows multi-vendor appliances to be added with no major changes to its core. This project mainly consist of three modules as follows.

- 1) User Interface
- 2) Wifi Router Configuration
- 3) Rasperry Pi
- 4) Relay circuit
- 5) Appliances .

4.2 Description of Modules

4.2.1.User Interface

User interface is everything that the user can see and interact with. In this module the android enabled phone makes control of the home automation system. Android provides a variety of pre-build UI components such as structured layout objects and UI controls that allow you to build the graphical user interface for your app. Android also provides other UI modules for special interfaces such as dialogs, notifications, and menus. the interface should allow user to view device status and to control device.

4.2.2.Wifi Router Configuration

The wifi unit provides the medium for communication .it can be also configured to make security services,the wifi should be configured with a certain address and user commands will be directing through wifi unit.you may use `sudo nano /etc/network/interfaces` for configuring wifi with rasperry-pi.

4.2.3.Rasperry Pi

The Rasperry 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 mini computer. Here we are using modelB ,700 MHz ARM processor with 512 MB RAM. The setting up of raspi consists of selecting raspbian OS from noobs package. the noobs package consists of raspbian,arclinux,pidora,open ELEC,risc OS operating system. After the os selection we need to configure rasperry-pi using Raspi-config command.we can enter into raspi desktop using startx command.

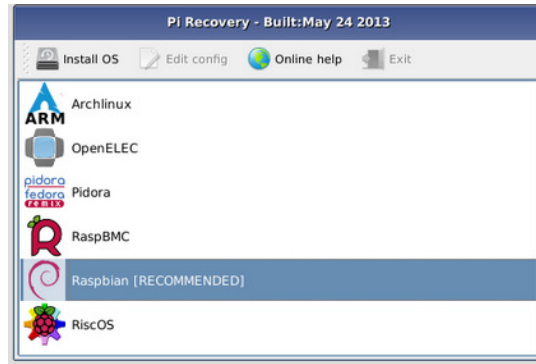


Fig.3 Noobs OS installation window

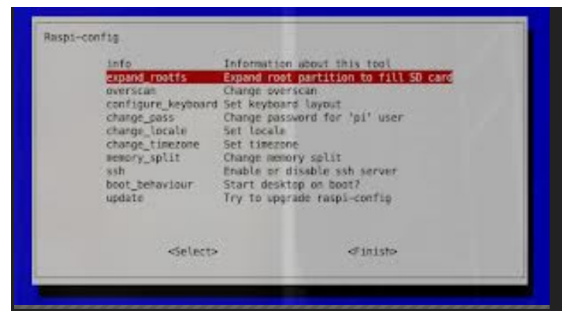


Fig.4 Raspberry-pi configuration using Raspi-config command

To interface rasperry-pi with the external world we can use WebIOPi. WebIOPi is a web application which allows to control Rasperry Pi's GPIO. It Support REST API over HTTP and CoAP .it can also handle more than 30 devices including ADC, DAC, sensors. The webIOPi interface allows better control of raspi.

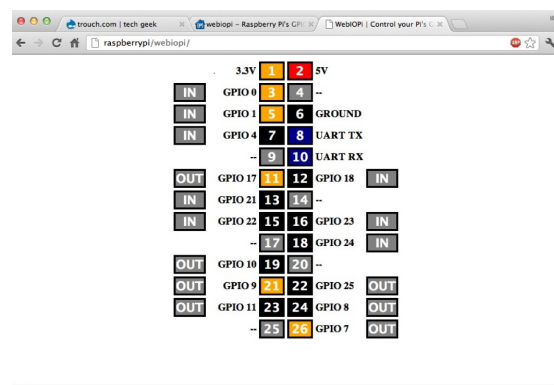


Fig:5 GPIO pin layout

The webLoPi Extensible and highly customizable and makes raspi control more efficient.

4.2.4 Relay Circuit

A relay is an electrically operated switch. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal. In our system the output from raspi is directly given to relay circuit. According to the output of raspi, corresponding relay will turn on and makes its device working. We are using an NPN transistor in relay and it works based on the concept of emf. The relay can be selected according to our application purpose.

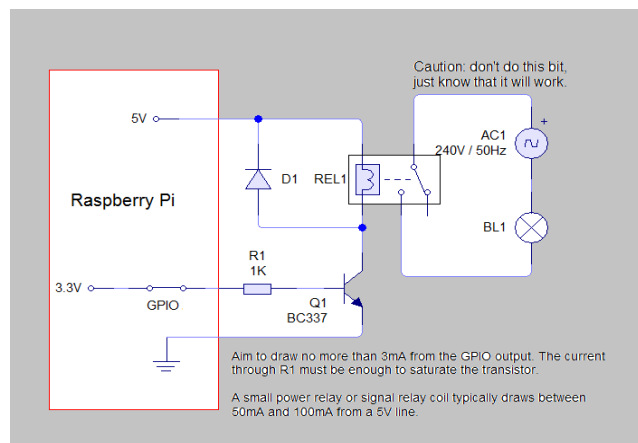


Fig.5 Relay connected with raspberry-pi

The home automation system ends up with the working of relay circuit. In this home automation system we can add devices very easily into the system. Also, it can be configured with more security and functional services. The Raspberry Pi mini computer can be made use more better to incorporate a variety of applications to our home automation system. Since our system makes running in low power compared to other systems, it is having a tremendous application view.

5. Conclusion

The system, as the name indicates, 'Android based home automation' makes the system more flexible and provides an attractive user interface compared to other home automation systems. In this system, we integrate mobile devices into home automation systems. A novel architecture for a home automation system is proposed using the relatively new communication technologies. The system consists of mainly three components: a Wi-Fi module, Raspberry Pi board, and relay circuits. Wi-Fi is used as the communication channel between an Android phone and the Raspberry Pi board. We hide the complexity of the

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

References

- [1] K. Bromley, M. Perry, and G. Webb. "Trends in Smart Home Systems, Connectivity and Services", www.nextwave.org.uk, 2003.
- [2] A. R. Al-Ali and M. Al-Rousan, "Java-based home automation system", *IEEE Transactions on Consumer Electronics*, vol. 50, no. 2, pp. 498-504, 2004.
- [3] N. Sriskanthan, F. Tan and A. Karande, "Bluetooth based home automation system", *Microprocessors and Microsystems*, Vol. 26, no. 6, pp. 281-289, 2002.
- [4] H. Ardam and I. Coskun, "A remote controller for home and office appliances by telephone", *IEEE Transactions on Consumer Electronics*, vol. 44, no. 4, pp. 1291-1297, 1998.
- [6] T. Saito, I. Tomoda, Y. Takabatake, J. Ami and K. Teramoto, "Home Gateway Architecture And Its Implementation", *IEEE International Conference on Consumer Electronics*, pp. 194-195, 2000.
- [7] N. Kushiro, S. Suzuki, M. Nakata, H. Takahara and M. Inoue, "Integrated home gateway controller for home energy management system", *IEEE International Conference on Consumer Electronics*, pp. 386-387, 2003.
- [8] S. Ok and H. Park, "Implementation of initial provisioning function for home gateway based on open service gateway initiative platform", *The 8th International Conference on Advanced Communication Technology*, pp. 1517-1520, 2006.
- [9] Mitchell, Gareth. "The Raspberry Pi single-board computer will revolutionise computer science teaching [For & Against]." *Engineering & Technology* 7.3 (2012): 26-26.
- [10] J. Bray, C. F. Sturman, "Bluetooth 1.1: Connect without Cable", Pearson Education, edition 2, 2001.