

Home Automation System Using Zigbee Technology

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Abstract: Home automation is becoming more popular day by day due to its numerous advantages. This can be achieved by a local networking (or) by remote control. We aim to design a basic home automation application on Raspberry Pi through reading the subject of the E-mail and the algorithm for the same has been developed in python environment which is default programming environment provided by the Raspberry Pi. Results show the efficient implementation of proposed algorithm for home automation.

Key words: Raspberry Pi, E-mail, Home Automation, Python

1. Introduction

Home automation refers to the application of computer and information technology for control of home appliances and domestic features. Its application varies from simple remote control of lighting to complex computer/micro-controller based networks involving varying degrees of intelligence and automation. Home automation results in convenience, energy efficiency, and safety benefits leading to improved quality of life. The popularity of network enabled home automation has been increasing greatly in recent years due to simplicity and much higher affordability.

Moreover, with the rapid expansion of the Internet, there is the potential for the remote control and monitoring of such network enabled appliances. However, the new and exciting opportunities to increase the connectivity of devices within the home for the purpose of home automation through internet are yet to be explored. Several definitions are available in the literature for home automation. Bromley et al (2003) describes home automation as the "introduction of technology within the home to enhance the quality of life of its occupants, through the provision of different services such as telehealth, multimedia entertainment and energy conservation". There has been significant research into the field of home automation with many other communication protocols like Bluetooth, hand gestures, DTMF etc. The XIO industry standard, developed in 1975 for communication between electronic devices, is the oldest standard identified from the author's review, providing limited control over household devices through the home's power lines. Sriskanthan et al (2002) introduced a Bluetooth based home automation system, consisting of a primary controller and a number of Bluetooth sub-controllers. AI-Ali et al (2004) developed a Java based home automation system. The use of Java technology, which incorporates built-in network security features, produces a secure solution. However, the system requires an intrusive and expensive wired installation and the use of a high end Pc. Baudelet et al (1993) proposed a novel control network, using hand gestures. The controller uses a glove to relay hand gestures to the system. Ardame et al (1998) introduced a phone based remote controller for home and office automation. The system differs in that all communications occur over a fixed telephone line and not over the Internet. This system can be accessed using any telephone that supports dual tone multiple frequency

(DTMF). This paper proposes a Raspberry Pi based home automation system through e-mails.

2. Raspberry PI Board

Raspberry Pi (shown in Figure 1) is a credit-card-sized single-board computer developed in the UK by Raspberry Pi foundation with the intention of stimulating the teaching of basic computer science in schools. It has two models; Model A has 256 Mb RAM, one USB port and no network connection. Model B has 512 Mb RAM, 2 USB ports and an Ethernet port. It has a Broadcom BCM2835 system on a chip which includes an ARM1176JZF-S 700 MHz processor, Video Core IV GPU, and an SD card. The GPU is capable of Blu-ray quality playback, using H.264 at 40 MBits/s. It has a fast 3D core accessed using the supplied OpenGL ES2.0 and OpenVG libraries. The chip specifically provides HDMI and there is no VGA support.



Figure 1: Raspberry Pi board

The foundation provides Debian and Arch Linux ARM distributions and also Python as the main programming language, with the support for BBC BASIC, C and Perl, detailed description of Raspberry Pi board has been given in Figure 2 (Raspberrypi user guide). Python was chosen as the main programming language, as it is generally accepted to be both easy to learn and a fully fledged, programming language suitable for real world applications. With the addition of NumPy, SciPy, Matplotlib, IPython, and PyLab, Python can be used for computational mathematics as well as for the analysis of experimental data or control systems (Ali et al-2013).

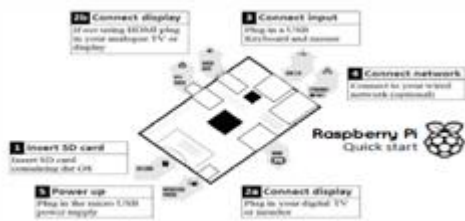


Figure 2: Description of raspberry Pi Board

This paper presents a basic application of Raspberry Pi inhome automation control through internet (E-mail) wheresubject of the received e-mail is read by the developed algorithmfed into raspberry Pi and system responds to the correspondinginstructions. The presented system is interactive, efficient andflexible according to the consumer needs. It immediately repliesthe status of work done by raspberry Pi to the consumer. Theproposed system has been tested practically using LEDs asswitching signal indicators, which can be seen in the presentedresults. The project can be extended for more applications apartfrom switching of home devices like surveillance, power monitoring, fault monitoring, power control, security etc.

3. Proposed System

Figure 3 describes the configuration of the proposed system.Raspberry Pi has been chosen as the processing unit for thesystem because of its user friendly features and economicalbenefits. Further, python coded algorithm has been fed into theraspberry Pi and is connected to the internet through Modulator Demodulator (MODEM) interface to access and send e-mails tothe consumer. The Devices to be controlled have beeninterfaced with raspberry Pi using relay driver circuit due todifferent power ratings of devices and raspberry Pi. A display (optional) may also be connected to view the instantaneousstatus and processing of raspberry Pi.

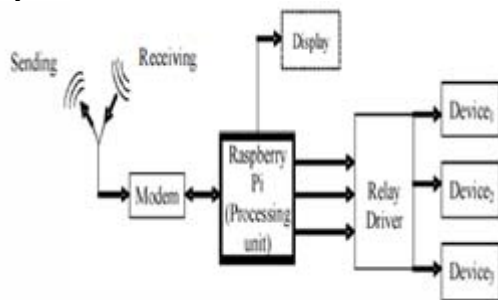


Figure 3: Layout of the proposed system configuration

The proposed system will control the devices connected to an ARM 11 based Raspberry pi board, through the commands from Email, and also send a feedback email of the status of the device. A human motion detection also be included using A PIR sensor, through which will receive an email alert of unauthorized motion detection.

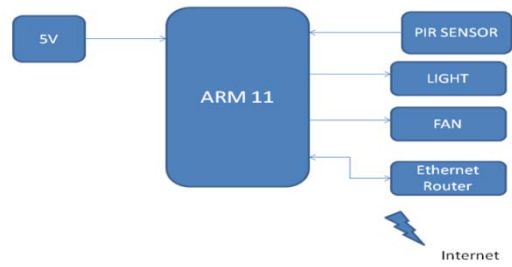


Figure 4: Block Diagram of the proposed system

4. Control Algorithm

The code for implementing the control strategy for home automation waswritten in python environment on Raspberry Pi. Firstly, thecode was set to initialize and log in into home g-mail account (gmail-imap) using the e-mail library of python IDE. Aftersuccessful initialization, Raspberry Pi starts reading thesubjects of e-mails from the account specified in the code. Thesubject of these e-mails is then compared from the initializingcommands of the interfaced devices and the control signal isgenerated according to it on the corresponding GPIO pin. Thisprocess is repeated continuously at an interval of 0.5 seconds. Figure 5 represents the algorithm of the used code in the form of flowchart.

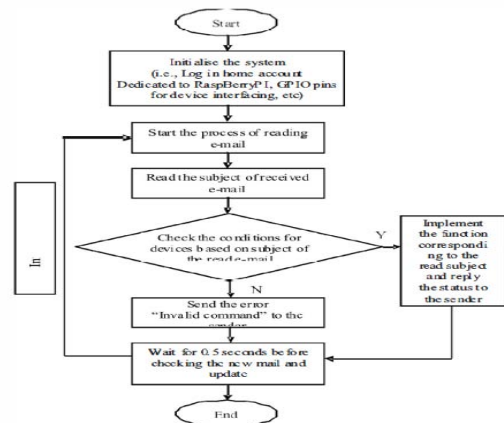


Figure 5: Flowchart of the control algorithm used

5. Performance Evaluation

For verification of the practicality of the proposed algorithm, LEDs were used to indicate the switching signal of the interfaced devices. The experimental setup is shown in Figure 6. Results were generated by a series of E-mails sent to the G-mail account of raspberry pi and the corresponding inbox and sentmails of raspberry G-mail account are shown in Figure 7and Figure 8, respectively.

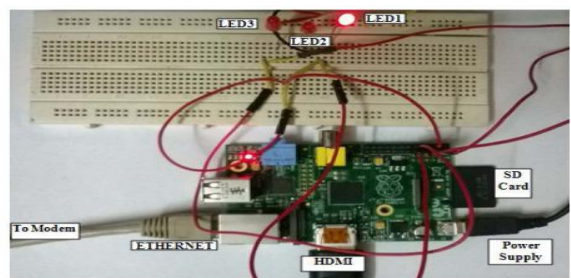


Figure 6: Working Experimental setup, responding to email with subject 'On I'

ON1 'was sent to rasp berry Pi account from the consumer account. The algorithm,read the subject 'ON1' and turned ON the device 1 represented by LED1 and instantly replied to sender by an email -'Turning ON switch 1' under the subject- 'Home automationactivated'. The code also includes exception handling in case of invalid e-mail from the consumer.

Similarly the same switch can be turned OFF by sending an e-mail with subject 'OFF1' to the raspberry Pi account. Further, This work consists of two more switches which can be controlled by sending e-mails under the subject- 'ON2' & 'ON3' to turn ON the switch2 & Switch3 and correspondingly - 'OFF2' & 'OFF3' to turn them OFF. So, the results show that home automation has been successfully implemented with efficiency and reliability.

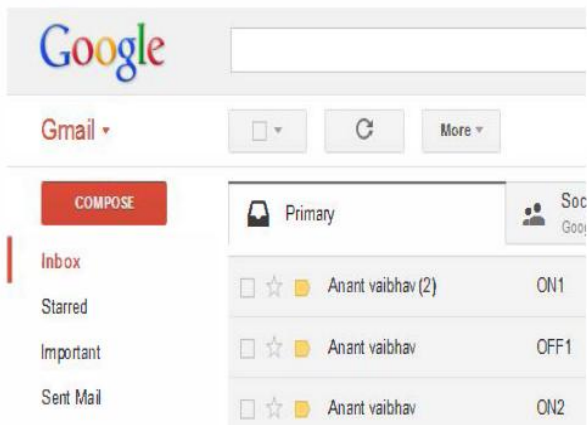


Figure 7: Screen shot of "INBOX" received on raspberry Pi

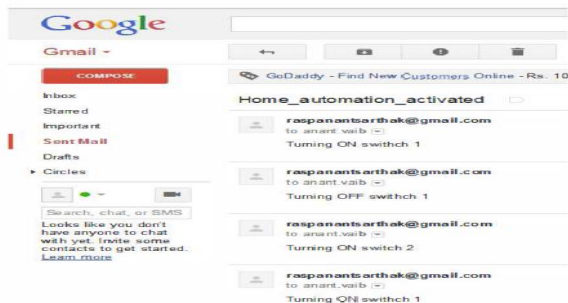


Figure 8: Screen shot of "SENT MAIL" from raspberry Pi

6. Conclusion

In this highly developing era, where directly or indirectly, everything is dependent on computation and information technology, Raspberry Pi proves to be a smart, economic and efficient platform for implementing the home automation. This paper provides a basic application of home automation using Raspberry Pi which can be easily implemented and used efficiently. The code provided is generic and flexible in a userfriendly manner and can be extended for any future applications like power control, surveillance, etc, easily. Moreover, this technique is better than other home automation methods in several ways.

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