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 aims to designing 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 anddomestic features. Its application varies from simple remotecontrol of lighting to complex computer/microcontroller basednetworks 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, thenew and exciting opportunities to increase the connectivity of devices within the home for the purpose of home automationthrough 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 X10 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 anumber of Bluetooth sub-controllers. Al-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 at (1993) proposed a novel control network, using hand gestures. The controller uses agloves to relay hand gestures to the system. Ardamen at (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. The 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 singleboard 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 25 6Mb RAM, one USB port and no network connection. Model B has 5 12Mb 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 40MBits/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 (Raspbeefl Pi user guide). Python was chosen as the main programming language, as it is generally accepted to be botheasy 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 etal-2013).
This paper presents a basic application of Raspberry Pi in home automation control through internet (E-mail) where subject of the received e-mail is read by the developed algorithm fed into raspberry Pi and system responds to the corresponding instructions. The presented system is interactive, efficient and flexible according to the consumer needs. It immediately replies the status of work done by raspberry Pi to the consumer. The proposed system has been tested practically using LEDs as switching signal indicators, which can be seen in the presented results. The project can be extended for more applications apart from 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 the system because of its user friendly features and economical benefits. Further, python coded algorithm has been fed into the raspberry Pi and is connected to the internet through Modulator Demodulator (MODEM) interface to access and send e-mails to the consumer. The Devices to be controlled have been interfaced with raspberry Pi using relay driver circuit due to different power ratings of devices and raspberry Pi. A display (optional) may also be connected to view the instantaneous status and processing of raspberry Pi.

4. Control Algorithm

The code for implementing the control strategy for home automation was written in python environment on Raspberry Pi. Firstly, the code was set to initialize and log in into home g-mail account (gmail-imap) using the e-mail library of python IDE. After successful initialization, Raspberry Pi starts reading the subjects of e-mails from the account specified in the code. The subject of these e-mails is then compared from the initializing commands of the interfaced devices and the control signal is generated according to it on the corresponding GPIO pin. This process is repeated continuously at an interval of 0.5 seconds. Figure 5 represents the algorithm of the used code in the form of flowchart.

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 sent mails of raspberry G-mail account are shown in Figure 7 and Figure 8, respectively.

Figure 2: Description of raspberry Pi Board

Figure 3: Layout of the proposed system configuration

Figure 4: Block Diagram of the proposed system

Figure 5: Flowchart of the control algorithm used

Figure 6: Working Experimental setup, responding to email with subject ‘On I’
ONI 'was sent to raspberry Pi account from the consumer account. The algorithm, read the subject 'ONI' and turned ON the device represented by LEDI and instantly replied to sender by an email - 'Turning ON switch 1' under the subject- 'Home automation activated'. 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 'OFFI' 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 user-friendly 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 is several ways.

References


